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THE

PRINCIPLES OF BOTANY,

AND OF

VEGETABLE PHYSIOLOGY.

TRANSLATED FROM THE GERMAN

OF

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PROFESSOR OF NATURAL HISTORY AND BOTANY
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TO

DANIEL RUTHERFORD, M. D.

PROFESSOR OF BOTANY

IN THE UNIVERSITY OF EDINBURGH,

THIS WORK IS

MOST RESPECTFULLY INSCRIBED

BY

THE EDITORS.

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Transl. Mrs Maria Elizabeth Jackson

ADVERTISEMENT.

The following work having superseded in Germany all other Introductions to Botany, of the longest standing and greatest reputation, it occurred to the present Editors that a translation of it would be a very acceptable present to the lovers of natural science in this country. They do not here intend to draw a comparison between this and the elementary treatises on Botany in our own language; but it may be allowable to say that it contains many things which are not to be found in any of them; particularly an explanation of the phenomena of Vegetable Physiology, on the principles of the latest discoveries in chemistry. There are also added sections on the Diseases of Plants, a History of the Science, and an account of Botanical Writers. The Plates illustrate every botanical term; and the table of Colours, which is altogether new, will be of essential use to students, not of Botany only, but also of Natural History in general.

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Harriet Maxwell
July-25-1826—

PRINCIPLES

OF

BOTANY, VEGETABLE PHYSIOLOGY, &c.

INTRODUCTION.

§ 1.

A CURSORY view of this world of matter ſhews, that it consists of bodies either simple or compound: the former are not to be decomposed by human art, whether mechanical or chemical, and these are called Elements, *(Elementa)*; the latter are made up of elements, and called Natural bodies, *(Naturalia.)*

The science which teaches the properties of Elements is called Natural Philosophy or Physics, *(Physica)*: but that science by which we become acquainted with the external forms and properties of Natural bodies is called Natural History.—*(Historia naturalis: scientia naturalis.)*

§ 2.

The innumerable multitude of bodies which form the province of Natural Hiſtory, obliged the writers on that subject, in the earliest times, to separate it into primary divisions under the name of Kingdoms. Aristotle was the first who established the division into the three kingdoms of Nature, namely, the Animal, Vegetable, and Mineral or Fossil Kingdoms*.—(*Regnum animale*, *vegetabile*, *lapideum vel minerale*.

§ 3.

The different manner of their propagation characterises the three Kingdoms of Nature. *Fossils* have no organs of generation; they remain always the same, or are only capable of forming various compounds, but never produce their like. *Plants* are furnished with a great number of genital organs; but they lose them before their death: *Animals*, on the contrary, retain these organs as long as life lasts†.

That

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* Some have added an Aqueous and an Igneous Kingdom; and Munchausen an intermediate kingdom containing the Fungi, Corallia and Polypi. Some naturalists have contented themselves with two kingdoms, the Living and Lifeless; but this last division is insufficient, because the former must be subdivided into Animals and Plants; and the other new kingdoms of nature are in like manner superfluous.

† Various means have been devised for discriminating Plants and Animals; but hitherto no one has been so fortunate as to discover a clear and satisfactory distinction, because nature has not separated them by any accurate limits. Motion from one place to another, the voluntary motion of particular parts, the orifice by which the food is taken in, and that by which the superfluous parts of it are discharged, are indeed characteristic

§ 4.

That science which teaches us to distinguish one plant from every other, and leads us to the knowledge of its properties, is called BOTANY, *(Botanice, Botanica, Scientia botanica, Phytologia, Botanologia.)*

To-teach this science properly, we must make the student acquainted with every particular part of a plant, and its use. This is the purpose of the following work: but before proceeding, we must premise a few necessary hints and general observations.

§ 5.

The first object of a student of Botany, after becoming acquainted with the Terminology, is to acquire an accurate knowledge of every plant as it comes in his way. He must possess what may be called a botanical eye, that he may be able to examine, with readiness, the stem, the leaves in all their varieties, the mode of inflorescence, and all the other conspicuous parts of a plant, so as to distinguish it with accuracy from those which resemble it. In this way he learns to know plants by their external appearance or habit *(habitus.)* With this knowledge, however, he must not be contented, but en-

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teristic marks of the animal kingdom, particularly of the larger animals. But there are certain plants which are endowed with voluntary motion, and which, in some respects, remove from one place to another, nor can any one shew us in the infusory animals, or in those allied to them, which resemble the Confervas, the Tremellas, and other small plants, the organs appropriated for the reception of tbe food or its discharge?

deavour to attain an intimate acquaintance with the parts of the flower and fruit, *(partes fructificationis)*, so as to be able to form distinct characters from these particulars; and, till he has attained this acquaintance, his knowledge cannot be said to rest on scientific principles. To derive the proper advantage from such knowledge, he must endeavour to imprint the form of the plant upon his memory. But as from the immense number of plants this is almost impossible, and often at particular seasons of the year, plants which we would wish to compare with one another are not to be found, we must endeavour to assist ourselves by a collection of dried plants, *(Hortus siccus, Herbarium)*. The rules to be observed in forming such a collection are the following.

1. The plant is to be laid between folds of blossom paper, the parts of it properly spread out, and the paper often changed, that the plant may not shrivel or become black: this is to be done in a moderately warm place, where the sun enters freely and the current of air is not interrupted.

2. In drying the plant we must take care to give the parts no direction which is unnatural to it; for instance, we must not give to a flower, which naturally hangs down, an erect position; flower-stalks that are attached to one side must not be turned to both, a bent or procumbent stem, must be preserved in that state, &c.

3. The plants must be gathered at that particular time when they possess all the characters by which they are distinguished from others. If the difference is found in the root, in the radical leaves, or in

the fruit, these parts, as being essential, must not be wanting.

4. Plants must not be gathered in moist weather, because at that time they generally turn black in drying; and when it so happens, they must be left to dry for some time in the air.

5. Succulent plants are dried either with a warm stone or a hot iron; or, which is better, they are dipt in boiling water, and kept there for some minutes and then dried in blossom paper in the usual way; but the paper must be often changed. The flowers must not be allowed to get wet, and they must be pressed softly.

6. Succulent, and at the same time tender plants, such as the Iris, must be dried between folds of writing paper, after one has previously bruised the capsule; but this paper is not to be opened till the whole plant is thoroughly dry.

7. The Lichens are dried in the common way.

8. But the Musci must be carefully plucked asunder, and thrown into a vessel of water, and then laid between two leaves of moistened writing paper, which may be put in an old book with a considerable weight on it.

9. A press is likewise used for thistles and other strong leaved plants.

10. The Fungi in general are not easily preserved, but the smaller and coriaceous kinds may be dried; and a few of the larger ones may be prepared by being plunged into boiling water.

When a collection of dried plants is thus made, they are to be laid each in a sheet of white paper, and arranged according to some system, and kept in a close locked cabinet, that they may not be eaten by insects. In the drawers likewise of such a cabinet may be placed small bits of spunge moistened with oil of rosemary or cajaput wrapt in paper, by which these depredators are kept off: even by frequent perusal the collection is preserved.

Some botanists, and Linnæus himself, advise the gluing or pasting of the plants to the paper. But many inconveniences attend this practice; for in this case we can only see one side of the leaf or of the flower, and when it is small we can hardly see it at all. For a botanist it is much more convenient to keep the plant loose, because it is often necessary with the help of warm water to unfold the flowers and observe their form; and he can substitute a better specimen occasionally for an indifferent one, which is not so easily done when the plant is pasted. If a person, however, wishes to fix his plants, he may use slips of paper laid over the stem, and pasted on each side, or he may fix them with a thread.

But an Herbarium alone is not sufficient for the purposes of a botanist; he must likewise collect and preserve the seeds of most plants and their fruit, especially those that can be easily kept, and he will find an acquaintance with these of great importance to him.

§ 6.

The outer surface of the different parts of plants is very multifariously formed. The following terms have been settled, and are used in descriptions of these various parts;

1. Glancing, (*nitidus*), where the surface is so smooth that it shines or glances, as in the leaves of the holly, Ilex *aquifolium*.

2. Even, (*levis*), without striæ, furrows, or raised dots. It is the opposite of Nos. 5, 6, 19, 20, 24 and 25,

3. Smooth, (*glaber*), when there are no visible hairs, bristles or thorns. It is the opposite of No. 7—18, and 23.

4. Dotted, (*punctatus*), where small fine dots are perceived by the eye, but not by the touch.

5. Rough, (*scaber*), where small raised dots are felt but not seen.

6. Rugged, (*asper*), when these dots are both felt and seen.

7. Hispid, (*hispidus*), beset with short stiff hairs.

8. Rigid, (*hirtus*), where the hairs are moderately long, but very stiff.

9. Hairy, (*pilosus*), beset with long single hairs, somewhat bent.

10. Villous, (*villosus*), where the hairs are long, soft and white.

11. Pubescent, (*pubescens*), overgrown with short fine white hairs.

12 Silky, (*sericeus*), when the surface is white and shining, by means of thick and almost invisible hairs.

13 Woolly, (*lanatus*), when the furface is beset with thick white hairs, so distinct as that they may be separated.

14. Tomentous, (*tomentosus*), when fine hairs are so matted together that the particular hairs cannot be separated. In this case the surface generally appears white, as in Shepherds Club, Verbascum; or of a rust colour, as in Ledum.

15. Bearded, (*barbatus*), when the hairs stand in tufts.

16. Strigose, (*strigosus*), when the surface is armed with small, close, rigid bristles, which are thickest below.

17. Stinging, (*urens*), where a painful burning sensation is caused by small hairs.

18. Fringed, (*ciliatus*), when on the margin of the surface there is a row of hairs of equal length.

19. Warty, (*papillosus*), when small fleshy warts appear.

20. Pustular, (*papulosus*), when there are small dimples or cavities.

21. Muricated, (*muricatus*), armed with small short spines.

22. Glutinous, (*glutinosus*), when the surface is covered with a slimy matter, which is soluble in water.

23 Viscid, (*viscidus*), when the surface is covered with a viscid matter which is resinous or greasy.

24 Striated, (*striatus*), when the surface is finely streaked.

25 Furrowed, (*sulcatus*), when these streaks form small furrows.

To

§ 7.

To signify the general appearances of vegetation, botanists often make use of figurative expressions. The various periods of vegetation are,

1. The germination, (*germinatio*), when the seed swells, and its little tender leaves begin to unfold.

2. Vernation, (*frondescentia*, *vernatio*), when the swollen buds of trees and shrubs unfold their leaves.

3. Sleep, (*somnus*), when in the evening, or during night, the leaves of various plants hang down or collapse.

4. Defoliation, (*defoliatio*), when in autumn, or, as is the case with a few northern plants, in the spring, the leaves fall off.

5. Virginity, (*virginitas*), that precise time when the flower-buds of plants are not yet unfolded.

6. Expansion, (*anthesis*), is the time when the flowers of plants are perfectly expanded. Thus in descriptions we say the flowers hang down before expansion (*flores ante anthesin nutantes*); or after expansion they stand erect, (*flores post anthesin erecti*).

7. Estivation, (*aestivatio*), so the month or season is called when the flower is in its greatest perfection.

8. Fructification, (*fructificatio*), is the preciſe period in plants when the autheræ communicate their dust to the neighbouring parts.

9. Caprification, (*caprificatio*), that species of impregnation which is performed without the immediate influence of the plants themselves.

10. Watchings, (*vigiliæ*), when flowers open or shut at a particular hour of the day or night.

11. Grossification, (*grossificatio*), when after florescence the future fruit begins to grow large.

12. Maturation, (*maturatio*), the time when the fruit becomes ripe.

13. Dissemination, (*disseminatio*), the means by which the fruit after it becomes ripe is disseminated.

N. In the Physiology we shall treat particularly of these several periods.

§ 8.

The various sizes of plants and of their parts has given occasion to the following measures.

1. A hair-breadth, (*capillus*), the measure of a hair, or the twelfth part of a line.

2. A line, (*linea*), the length of the white crescent at the root of the nail of the middle finger, or the twelfth part of an inch.

3. A nail length, (*unguis*), the length of the nail of the middle finger, or half an inch.

4. An inch, (*pollex*, *uncia*), the length of the first joint of the thumb, the twelfth part of a foot.

5. A hand-breadth, (*palmus*), the breadth of the four fingers of the hand, or three inches.

6. A ſpan, (*dodrans*), as far as one can span with the thumb and the little finger, or nine inches.

7. A small span, (*spithama*), as far as one can span with the thumb and forefinger, or seven inches.

8. A foot, (*pes*), the length from the elbow to the origin of the hand, or twelve inches.

9. A cubit, (*cubitus*), from the elbow to the point of the middle finger, or seventeen inches.

10. An ell, (*ulna*, *brachium*), the length of the whole arm or four and twenty inches.

11. A fathom, (*orgya*), the length of the arms stretched out from the tip of one middle finger to that of the other, or six feet.

TERMINOLOGY.

§ 9.

In the descriptions of plants it is necessary that each part have its particular name, and every variety of it be marked by an appropriate expression, that it may be known from every other. Thus, in each plant the beginner must distinguish the following parts: the root (*radix*), the stem (*caulis*), the leaves (*folia*), the props (*fulcra*), the flower (*flos*), and the fruit (*fructus*).

§ 10.

The root (*radix*), supplies the plant with the principal part of its nourishment; it is commonly hid in the ground, and by it the vegetable is firmly fixed in its place. Most plants have roots, and where they appear to be wanting, as in some lichens, their place is supplied by small tubercles. In general the Musci and Fungi are furnished with roots, though this was formerly denied. The slender fibres which proceed from roots are called radicles, (*radiculæ*).

The shoots which a root sometimes sends from its sides are called suckers (*stolones*).

The definition of a root in botanical terminology is different from that in physiology. The former considers every thing as root which is hid in the earth, with the exception of such parts as resemble buds. The latter calls only that root which serves for keeping the plant firm in the ground, or for conveying its nourishment: thus all the bulbous and fleshy roots, as they are called, are, strictly speaking, not roots; the fibres are the real roots; but more of this in the Physiology.

§ 11.

The various kinds of roots are the following:

1. Spindle-shaped, (*fusiformis*): perpendicular, thick above, and growing smaller as it descends, as in the carrot, Daucus *carota*, parsnip, Pastinaca *sativa*.

2. Perpendicular, (*perpendicularis*), that is equally thick and goes perpendicularly into the ground, as in the shepherd's purse, Thlaspi *bursa pastoris*.

3. Horizontal, (*horizontalis*), that lies horizontally in the ground, as in the common polypody, Polypodium *vulgare*, fig. 15.

4. Oblique, (*obliqua*), when the root lies obliquely in the ground, somewhat between the perpendicular and horizontal, as in thrift, Statice *armeria*.

5. Creeping, (*repens*), when the root creeps horizontally under the earth, and at intervals pushes up stems, as in the couch-grass, Triticum *repens*.

6. Bitten, (*præmorsa*), where the principal root appears as if a part of it were bitten off, as in devil's bit, Scabiosa *succisa*, the larger plantain, Plantago *major*.

7. Branched, (*ramosa*), divided into many ramifications, as in all trees and most plants.

8. Fibrous, (*fibrosa*), when the root consists of a multitude of small fibres, as in most Grasses.

9. Tuberous, (*tuberosa*), when certain fleshy protuberances called knobs, adhere to the root, as in the potatoe, Solanum *tuberosum*, Sagittaria *sagittifolia*, Brassica *oleracea*, Napobrassica, &c. Of this there are the following kinds.

a. Granulated, (*granulata*), when the knobs are formed like small tubercles, as in Saxifraga *granulata*.

b. Spherical, (*globosa*), when the knobs are large, and of a round, spherical shape, as in the radish, Raphanus *sativus*.

c. Turnip-shaped, (*napiformis*), where the knobs are round or longish, but run into a sharp point, as in the common turnip, Brassica *rapa*.

d. Oblong, *oblonga*, where the knobs are large, and are more or less of a longish shape, as in the potatoe, Solanum *tuberosum*.

e. Hanging, (*pendula*), is like the preceding, only the long-shaped knobs hang by threads or fibres, as in the Spiræa *Filipendula*.

f. Hollow, (*cava*), when the long knobbed root, as soon as it attains its full growth, becomes hollow, without being made so by insects, as in Fumaria *cava*, Retz.

g. Testiculated, (*testiculata*), when two longish knobs grow together, as in the Orchis *Morio*, fig. 18.

h. Palmated, (*palmata*), when two longish knobs are connected and their points divided, as in the Orchis *latifolia*, fig. 16.

i. Bundled, (*fascicularis*), when cylindrical-shaped knobs are connected at their origin, as in the Ophrys *nidus avis*, fig. 21.

10. Dentated, (*dentata*), a fleshy branched root, having teeth-like shoots, as in Ophrys *corallorhiza* fig. 13.

11. Scaly, (*squamosa*), a fleshy root, covered with many scales, as in Lathræa *squamaria*.

12. Articulated, (*articulata)*, fleshy, filiform and articulated, as in wood sorrel, Oxalis *acetosella**.

§ 12.

The Stem serves chiefly for the elevation of the leaves, flowers and fruit, and is a support to the whole plant. Of this the following kinds are known. The stem (*caulis*), the trunk (*truncus*), the straw (*culmus*), the stalk (*scapus*), the footstalk of the flower (*pedunculus*), the footstalk of the leaf

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* The tuberous root and its varieties are very different from the bulbous, (*bulbus*, §. 43), which appears particularly from this, that buds or eyes are formed on the surface of the former, whereas the bulb is itself a bud, and produces its shoots either from the middle or from the side.

(*petiolus*), the stipe (*stipes*), the shoot (*surculus*), and the bristle (*seta.*)

§ 13.

The Stem (*caulis*), is peculiar to herbaceous plants, and elevates leaves, flowers and fruit. Its separate shoots are called branches (*rami*). Of the stem the following kinds are known.

a. *Simple Stems.*

1. Quite simple, (*simplicissima*), without any branches.

2. Simple, (*simplex*), with very few branches.

3. Entire, (*integer*), so called when furnished with a few branches that stand close together; the same term is also used when a simple stem is compared with a branched one.

4. Somewhat branched, (*subramosus*), that sometimes has one or two branches.

b. *Branched Stems.*

5. Branched, (*ramosus*), divided into several branches.

6. Much branched, (*ramosissimus*), where all the branches are subdivided into a number of other branches.

7. Verticillated, (*prolifer* v. *verticillatus*), when from the point there issue a number of branches, from the middle of which the trunk grows, so that the branches seem to surround the stem in a circular form, as in the Scotch fir, Pinus *sylvestris.*

8. Dichotomous, (*dichotomus*), when the stem, even to the smallest branches, is divided into pairs, as in the misletoe, Viscum *album*, and Valeriana *olitoria*.

c. *Stems differing in respect of the Branches.*

9. Alternate branches, (*rami alterni*). The branches are so placed that between two on the one side there rises but one on the opposite side.

10. Opposite branches, (*rami oppositi*), when one branch stands on the opposite side to another, and the bases of each nearly meet together.

11. Distichous, (*distichus*), when the branches being opposite to each other, stand on the same plane.

12. Scattered, (*sparsus*), when the branches stand without order on the stem.

13. Close, (*confertus*), when the branches stand so thick, and without order, that no empty space remains between them.

14. Brachiate, (*brachiatus*), when opposite branches stand at right angles with each other, or cross-wise.

15. Rod-like, (*virgatus*), when the branches are very long, weak and thin.

16. Fastigiate, (*fastigiatus*), when all the branches from bottom to top are of such different lengths that they are of equal height.

17. Compact, (*coarctatus*), where the tips of the branches are bent inwards towards the stem.

18. Spreading, (*patens*), when the branches stand nearly at right angles with the stem.

19. Diverging, (*divergens*), where the branches form a right angle.

20. Divaricated, (*divaricatus*), where the branches are so situated that they form an obtuse angle above, and an acute angle below.

21. Deflected, (*deflexus*), the branches hang down, forming an arch.

22. Reflected, (*reflexus*), where the branches hang so much down that they almost run parallel with the stem.

23. Retroflected, (*retroflexus*), where the branches are bent towards every side.

d. *Stems differing in respect of Situation.*

24. Erect, (*erectus*), when the stem stands nearly perpendicular.

25. Straight, (*strictus*), where the stem is perpendicular, and quite straight.

26. Stiff, (*rigidus*), when it is so stiff that it does not bend but break.

27. Limber, (*laxus*), waving with the smallest motion of the wind.

28. Bent upwards (*adscendens*), when the stem lies on the ground, but the upper part of it stands erect.

29. Bent downwards (*declinatus*), when the stem is so bent towards the earth that it forms an arch.

30. Supported (*fulcratus*), that from above sends roots down into the earth, which afterwards change into real stems, as in the Rhizophora.

31. Bent inwards, (*incurvus*), when the point is bent in.

23. Nodding, (*nutans*), when the point is bent down towards the horizon.

33. Procumbent, (*procumbens*, *prostratus*, *humifusus*), when the stem lies flat on the ground.

34. Decumbent, (*decumbens*), when the stem is upright below, but above is bent down towards the ground, so that the greatest part of it is procumbent.

35. Creeping, (*repens*), when the stem lies along, and sends out roots from below.

36. Sarmentose, (*sarmentosus*), when the stem lies along, but sends out roots only at certain intervals, fig. 20.

37. Rooting, (*radicans*), when the stem stands upright and climbs, every where sending forth small roots by which it holds itself fast, as in the ivy, Hedera *Helix*.

38. Flexuose, (*flexuosus*), where the upright stem bends itself in a zig-zag manner, so as to form a number of obtuse angles, fig. 14.

39. Climbing, (*scandens*), a weak stem that fastens itself to some other body for support, as the passion-flower, Passiflora *cœrulea*.

40. Twining, (*volubilis*), a weak stem that twine in a serpentine form round other plants; it is of two kidns.

- *a.* Turning from the right, (*dextrorsum*), when the stem twines from the left to the right, round a supporting body, as in the bindweed, Convolvulus, fig. 25.
- *b.* Turning from the left, (*sinistrorsum*), when the stem twines from the left to the right, round a supporting body, as in the hop, Humulus *Lupulus*. Fig. 32.

e. *Difference of Stems in respect of Clothing.*

41. Naked, (*nudus*), having no leaves, scales, or the like.

42. Leafless, (*aphyllus*), without any leaves.

43. Scaly, (*squamosus*), covered with scales.

44. Leafy, (*foliosus*), having leaves.

45. Bulbiferous, (*bulbifer*), having buds or bulbs in the axillæ of the branches, as in the bulbiferous lily, Lilium *bulbiferum*.

46. Perfoliated, (*perfoliatus*), when the stem goes through a leaf, as in Bupleurum, fig. 38.

f. *Difference of Stems in respect of Figure.*

47. Round, (*teres*), that is quite cylindrical, fig. 25, 27, 32.

48. Half-round, (*semi-teres*), that is round on the one side, and flat on the other, fig. 235.

49. Compressed, (*compressus*), when the stem is flat on both sides.

50. Two-edged, (*anceps*), when a compressed stem is sharp on both edges.

51. Angled, (*angulatus*), when a stem has several angles, but the sides are grooved. Of this there are several kinds, *viz.*

α. Obtuse-angled, (*obtuse angulatus*).
β. Acute-angled, (*acute angulatus*).
γ. Three-angled, (*triangularis*).
δ. Four-angled, (*quadrangularis*, &c.), fig. 237.
ε. Many-angled, (*multangularis*).

52. Three-sided, (*triquetrus*), where there are three sharp corners, and the sides quite flat, fig. 236.

53. Three-cornered, (*trigonus*), when there are three round or obtuse edges, but the sides appear flat. Of this too there are several kinds:

α. Four-cornered, (*tetragonus*), fig. 29.
β. Five-cornered, (*pentagonus*).
γ. Six-cornered, (*hexagonus*).
δ. Many-cornered, (*polygonus*).

54. Membranaceous, (*membranaceus*). When the stem is compressed and thin like a leaf.

55. Winged, (*alatus*), when on both sides of the stem there is a membranaceous dilatation, fig. 265.

56. Knotted, (*nodosus*), when the stem is divided by knobs.

57. Knotless, (*enodis*), when it has neither knobs nor joints.

58. Articulated, (*articulatus*), when the stem has regular knobs at the joints, as in Cactus, fig. 233.

59. Jointed, (*geniculatus*), when the stem has regular knobs not seated on the joints.

g. *Difference of Stems in respect of Substance.*

60. Woody, (*lignosus*), that consists of firm wood.

61. Fibrous, (*fibrosus*), that consists of woody fibres, that can be easily separated.

62. Herbaceous, (*herbaceus*), that is weak, and can be easily cut.

63. Fleshy, (*carnosus*), that is nearly as juicy and soft as the flesh of an apple.

64. Firm, (*solidus*), internally hard.

65. Empty, (*inanis*), filled internally with a soft pith.

62. Hol-

66. Hollow, (*fistulosus*), without any pith within, and quite hollow.

67. With separations, (*septis transversis interstinctus*), where either the pith or the hollow space is divided by thin partitions.

68. Cork-like, (*suberosus*), when the outer rind is soft and spungy, as in the Ulmus *suberosa*.

69. Rifted, (*rimosus*), when there are in the rind thin clefts or chinks *.

§ 14.

The TRUNK, (*truncus*), is proper to trees and shrubs. It is twofold: 1. *Truncus arboreus*, that has a crown of branches at top: 2. Truncus *fruticosus*, that has branches also below.

§ 15.

The STRAW, (*culmus*), is proper only to the Grasses: the kinds of it are pretty much the same with those of the stem. It is however commonly knotted (*nodosus*), seldom knotless (*enodosus*), almost always simple (*simplex*), seldom branched (*ramosus*). In some it is bristle-like (*setaceus*), without vagina, and therefore naked, (*nudus*); or surrounded by the vaginæ of the leaves (*vaginatus*). For the surface, see § 6.

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* The surface of the stem has also many varieties; see § 6. When a sort of stem occurs in plants which does not come under the above definitions exactly, we use the word *sub*, as in the leaves, § 23, and in other parts of plants: accordingly we say, *caulis subaphyllus*, *subteres*, &c. that is, a stem almost leafless, somewhat round, &c.

§ 16.

The STALK *(scapus)*, differs from thestem in this, that it issues straight from the root, and bears only flowers, as in the lily of the valley, Convallaria *majalis ;* Sagittaria *sagittifolia*, *&c.* fig. 44. Its varieties are denominated like those of the stem. Linnæus has improperly, in some of the Filices, used the term *scapus caulinus.*

§ 17.

The FLOWER-STALK, *(pedunculus)*, is found close under the flower, and may be either a principal stem or stalk, as in fig. 23, 27, 38, 44. The sorts are,

1. One-flowered, *(uniflorus)*, bearing only one flower, fig. 23, 27.

2. Two or three-flowered, &c. *(bi-triflorus)*, &c.

3. Common, *(communis)*, when several flower-stalks unite in a common one. This flower-stalk is much branched, and the partial stalks are then called *Pedicelli*, *pediculi.*

4. Radical *(radicalis)*, when a single flower-stalk rises from the root, as in the violet, Viola *odorata.*

5. Petiolar, *(petiolaris)*, when the flower-stalk is inserted in the leaf-stalk.

6. Axillary, *(axillaris)*, when it is fixed in the angle between the stem and the leaves.

7. Lateral, *(lateralis)*, when the flower-stalk is found on the branches where there are no leaves, or on the shoots of the former year, as in Boehmeria *ramiflora.*

8. Opposite, *(oppositiflorus)*, when the particular flower-stalks stand quite opposite to one another.

9. Opposite to the leaf, (*oppositifolius*), when it stands on the other side exactly opposite to the leaf.

10. Beside the leaf, (*laterifolius*), when it sits on the stem by the side of the leaf.

11. Under the leaf, (*extrafoliaceus*). when it is seated under the leaf.

12. Between the leaves, (*intrafoliaceus*), when it is seated on the stem between the leaves.

§ 18.

The leaf-stalk, (*petiolus*), bears only leaves. Its kinds are,

1. Round, (*teres*), as in most plants.

2. Compressed, (*compressus*), as in the trembling poplar, Populus *tremula*.

3. Channelled, (*canaliculatus*), when there is on the surface a deep longitudinal furrow, as in the butter-bur, Tussilago *Petasites*, Angelica *Archangelica*.

4. Winged, (*alatus*), when there is a leaf-like expansion on two opposite sides of the leaf-stalk, as in the orange, Citrus *aurantium*, fig. 2.

N. The petiolus is denominated, as to figure and surface, like the stem.

§ 19.

Stipe, (*stipes*). This term is applied only to the Filices, Fungi and Palms. The different sorts of it are denominated like those of the stem.

In the Fungi the stipes is,

1. Ringed, (*annulatus*), § 38, fig. 4.

2. Naked, (*nudus*), having no rings, fig. 223, 224, 286.

3. Scaly, (*squamosus*), covered with distinct small scales.

§ 20.

The shoot, (*surculus*), is a term applied to the stem which bears the leaves of the mosses. Of this there are the following varieties.

1. Simple, (*simplex*), having no branches, as in the Polytrichum *commune*, fig. 139, 142.

2. Branched, (*ramosus*), dividing into branches, as in Mnium *androgynum*, fig. 138.

3. With hanging branches, (*ramis deflexis*), when the stem is branched, but all the branches hang down, as in Sphagnum *palustris*.

4. Decumbent, (*decumbens*), that lies on the ground.

5. Creeping, (*repens*).

6. Upright, (*erectus*).

§ 21.

The bristle, (*seta*), is that sort of stem which bears only the fructification of the mosses, fig. 140. It is always simple, and there are no other sorts of it than in respect of position. It is sometimes single, (*solitaria*), ſometimes crowded (*aggregata*), sometimes on the point (*terminalis*), or on the side (*axillaris, lateralis*).

N. Plants that want the stem are called *Plantæ acaules.*

§ 22.

The LEAVES, (*folia*), are distinguished and denominated according as they are simple or compound, according to their situation, substance, or position, their attachment or direction. Every simple leaf must be considered in respect of its apex, its base, its circumference, its margin and its two surfaces.

A. Simple Leaves.

a. *In respect of the Apex.*

A leaf is said to be

1. Acute, (*acutum*), when the leaf ends in a point, fig. 68.

2. Acuminated, (*acuminatum*), when the point is lengthened out, fig. 200.

3. Pointed, (*cuspidatum*), when the lengthened out point ends in a small bristle, fig. 198.

4. Obtuse, (*obtusum*), when the end of the leaf is blunt or round, fig. 25.

5. Mucronate, (*mucronatum*), when there is a bristle-shaped aculeus, situated on the round end of a leaf, as in the Amaranthus *Blitum.*

6. Bitten, (*præmorsum*), when the leaf is as it were bitten off at the point, forming a curved line, as in the Pavonia *præmorsa.*

7. Truncated, (*truncatum*), when the point of the leaf is cut across by a straight line, as in the Liriodendron *tulipifera.*

8. Wedge-shaped, (*cuneiforme*), when a truncated leaf is pointed on both ſides at the base.

9. Dedaleous, (*dædaleum*), when the point has a large circuit, but is truncated and ragged.

10. Emarginated, (*emarginatum*), when an obtuse pointed leaf has a part as it were taken out of the apex, fig. 31.

11. Retuse, (*retusum*,) when an obtuse leaf is somewhat emarginated, but in a small degree.

12. Cleft, (*fissum*), when there is a cleft at the point extending half way down the leaf. When there is but one cleft at the point, the leaf is called bifid, (*folium bifidum*); if there are two clefts it is called trifid, (*trifidum*), fig. 23.; if there are more clefts, the leaf is called *quadrifidum*, *quinquefidum* &c. *multifidum*, with many clefts.

13. Fan-shaped, (*flabelliforme*), when a truncated cuneiform leaf is at the point once or oftener cleft.

14. Tridentated, (*tridentatum*), when the point is truncated, and has three indentations.

b. *In respect of the Base.*

15. Heart-shaped, (*cordatum*), when the base is divided into two round lobes, the anterior part of the leaf being ovate, 20, 27, 203.

16. Kidney-shaped, (*reniforme*), when the base is divided into two round separate lobes, and the anterior part of the leaf is round.

17. Moon-shaped, (*lunatum*), when both lobes at the

the base have either a straight or somewhat arched line, and the anterior part of the leaf is round.

18. Unequal, (*inæquale*), when one side of the leaf is more produced than the other, fig. 248.

19. Arrow-shaped, (*sagittatum*), when the base is divided into two projecting pointed lobes, and the anterior part of the leaf is likewise pointed, fig. 44.

20. Spear-shaped, (*hastatum*), when the two pointed lobes of the base are bent outwards.

21. Ear-shaped, (*auriculatum*), when there are at the base two small round lobes bent outwards. It is nearly the hastate leaf, only the lobes are smaller and round, fig. 292.

c. *In respect of Circumference.*

22. Orbicular, (*orbiculatum*), when the diameter of the leaf on all sides is equal.

23. Roundish, (*subrotundum*), differs little from the foregoing, only that the diameter is longer, either from the base to the apex, or from side to side.

24. Ovate, (*ovatum*), a leaf which is longer than it is broad; the base is round and broadest, the apex narrowest.

25. Oval or elliptical, (*ovale* s. *ellipticum*), a leaf whose length is greater than its breadth, but round both at base and apex.

26. Oblong, (*oblongum*), when the breadth to the length is as 1 to 3, or the breadth always least, but the apex and base vary, that is, they are sometimes obtuse, sometimes pointed.

27. Parabolic, (*parabolicum*), a leaf is so called which is round at the base, then forms a small bend, and grows less towards the point, fig. 245.

28. Spatulate, (*spatulatum*), when the fore part of a leaf is circular, growing smaller towards the base, as in the Cucubalus *Otites*, fig. 238.

29. Rhombic, (*rhombeum*), when the sides of the leaf run out into an angle, so that the leaf represents a square, fig. 22.

30. Oblique, (*subdimidiatum*), is that leaf which has one side broader than the other. Of this leaf there are several varieties, as,

a. Heart-shaped oblique, (*sub-dimidiato-cordatum*), a heart-shaped leaf, which is at the same time oblique, as in the Begonia *nitida*, fig, 197.

b. Trapeziform, (*trapeziforme*), a rhombic leaf, with one side smaller than the other, &c.

31. Panduræform, (*panduræforme*), when an oblong leaf has a deep curve on both sides, fig. 24.

32. Sword-shaped, (*ensiforme*), an oblong leaf, growing gradually narrower towards the apex, which is pointed; the sides are flat and have more or less of an arch-like form, as in the sword-flag, Iris.

33. Lanceolate, (*lanceolatum*), an oblong leaf, which grows gradually narrower from the base to the point.

34. Linear, (*lineare*), when both sides of a leaf run parallel to each other, so that it is equally broad at the base and the apex, fig. 29.

35. Capillary, (*capillaris*), when a leaf has scarcely any breadth, and is as fine as a thread or hair.

36. Awl-shaped, (*subulatum*), a linear leaf, which is sharply pointed.

37. Needle-shaped, (*acerosum*), a linear leaf that is rigid, and generally endures through the winter, as in the pine-tribe, Pinus.

38. Triangular, (*triangulare*), when the circumference represents a triangle, the apex of which makes the point of the leaf, as in the birch, Betula *alba*.

39. Quadrangular, quinquangular, (*quadrangulare*, *quinquangulare*), when the circumference of the leaf has 4 or 5 angles, as in the Menispermum *canadense*.

40. Intire, (*integrum* s. *indivisum*), which is not at all cleft or divided, fig. 203.

41. Lobed, (*lobatum*), when a leaf is deeply divided nearly half its length into lobes. According to the number of lobes it is denominated bi-lobed (*bi-lobum*), as in Bauhinia; tri-lobed, (*tri-lobum*), quinquelobed, (*quinquelobum*), as in the hop, Humulus *Lupulus*, &c. fig. 32.

42. Palmated, (*palmatum*), when there are five or seven very long lobes, that is, when the segments are more than half way divided.

43. Divided, (*partitum*), when in a roundish leaf the division extends to the base.

44. Torn, (*laciniatum*), when an oblong leaf has several irregular clefts.

45. Sinuated, (*sinuatum*), when on the sides of an oblong leaf there are round incisures, as in the oak, Quercus *robur*, fig. 289.

46. Pinnatifid, (*pinnatifidum*), when there are regular incisures, that go almost to the middle rib, fig. 15.

47. Lyre-shaped, (*lyratum*), nearly the foregoing leaf, whose outer segment is very large and round, fig. 243.

48. Runcinate, (*runcinatum*), when the incisures of a pinnatifid leaf are pointed, and form a curve behind, as in the dandelion, Leontodon *Taraxacum*, fig. 242.

49. Squarroso-laciniate, (*squarroso-laciniatum*), when the leaf is cut almost into the middle rib, and the incisures run in every direction, as in the thistle, Carduus *lanceolatus*, fig. 265.

N. The contour of the leaves from No. 41 to 43 is round. From No. 44 to 49 it is oblong.

d. *In respect of the Margin.*

50. Quite entire, (*integerrimum*), when the margin is without either notch or indentation, fig. 1. 2.

N. This No. 50. and No. 40. are often confounded. *An intire* leaf is merely the opposite of the numbers from 40 and 41 to 49. It may often be either dentated or serrated. A *quite intire* leaf may indeed be formed like numbers from 41 to 47, but it can have no indentations or serratures, as in the following leaves.

51. Cartilagineous, (*cartilagineum*), when the margin consists of a border of a harder substance than the disk.

52. Undulated, (*undulatum*), when the margin is alternately bent in and out, fig. 39, 197.

53. Crenated, (*crenatum*), when the margin is set with small and round notches, having at the same time a perpendicular position.

54. Repand, (*repandum*), when there are on the margin small sinuses, and between them segments of a small circle, fig. 20.

55. Toothed, (*dentatum*), when the margin is set round with small pointed and distinctly separated teeth, fig. 32.

56. Duplicato-dentate, (*duplicato-dentatum*), when each small tooth of the margin is again dentated, as in the elm, Ulmus *campestris*, fig. 248.

57. Dentato-crentate, (*dentato-crenatum*), when each tooth is set with small and round denticuli.

58. Serrated, (*serratum*), when the teeth on the margin are very sharp pointed, and stand so close that one seems to lie on the back of another.

59. Gnawed, (*erosum*), when the margin is unequally sinuated, as if it had been gnawed, as in some species of sage, Salvia.

60. Spiny, (*spinosum*), when the margin is set with spines, as in the thistle, Carduus.

61. Fringed, (*ciliatum*), when the margin is set round with strong hairs, of equal length, and at a considerable distance from one another.

e. *In respect of their Surface.*

62. Aculeated, (*aculeatum*), when the surface is covered with spines.

63. Hollow, (*concavum*), when there is a hollow in the middle of the leaf.

64. Channelled, (*canaliculatum*), when the middle rib of a long and narrow leaf is furrowed.

65. Wrinkled, (*rugosus*), when the surface is raised between the veins of the leaf, and thus forms wrinkles, as in sage, Salvia.

66. Bullate, (*bullatum*), when the parts raised between the veins on the surface appear like blisters.

67. Pitted, (*lacunosum*), when the raised places between the veins are on the under surface, so that the upper surface appears pitted.

68. Curled, (*crispum*), when the leaf is fuller on the margin than in the middle, so that it must lie in regular folds, fig. 35.

69. Folded, (*plicatum*), when the leaf lies in regular straight folds from the base.

70. Veined, (*venosum*), when the vessels of a leaf rise out of the middle rib. This is the case in most plants, fig. 2, 14, 25, 27, 245, 248, 289, &c.

71. Netwise veined, (*reticulato-venosum*), when the veins which rise from the middle-rib again subdivide into branches that form a sort of net-work.

72. Ribbed, (*costatum*), when veins arise out of the middle, and proceed in a ſtraight line towards the margin in considerable numbers and close together, as in the Calophyllum *Inophyllum*, Canna, Pisang, Musa, &c.

73. Nerved, (*nervosum*), when the vessels rising out of the petiolus run from the base to the apex, fig. 200, 203.

74. Three-nerved, (*trinervium*), when three nerves take their origin from the base, fig. 100. Thus we

likewise say, *quinquenervium*, *septemnervium*, fig. 203, &c.

75. Triple-nerved, (*triplinervium*), when out of the side of the middle rib above the base there arises a nerve running towards the point, as in Laurus *Cinnamonum*, and *Camphora*, fig. 290.

76. Quintuple-nerved, (*quintuplinervium*), when out of the middle rib, above the base, there arise two nerves running towards the point, fig. 201.

77. Septuple-nerved, (*septuplinervium*), when on each side of the middle rib above the base three nerves arise and proceed to the apex, fig. 202.

78. Venoso-nerved, (*venoso-nervosum*), when in a leaf having nerves, the vessels run into branches as in a veined leaf, as in the Indian cress, Tropæolum *majus*, fig. 197, 198.

79. Streaked, (*lineatum*), when the whole leaf is full of smooth parallel vessels that run from the base to the apex*.

80. Nerveless, (*enervium*), when no nerves rise from the base.

81. Veinless, (*avenium*), where there are no veins.

82. Dotted, (*punctatum*), when instead of ribs or veins there are dots or points, as in the Vaccinium *vitis idæa*.

83. Coloured, (*coloratum*), a leaf of some other colour than green.

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[*] Linnæus often calls that a *folium lineatum* which is veined, but where the veins run in pretty straight lines, and are highly raised, as in the Zizyphus *volubilis*.

84. Cowled, (*cucullatus*), when in a heart-shaped eaf the lobes are so bent towards each other as to have the appearance of a cone.

85. Convex, (*convexum*), when the middle of the leaf is thicker than the rim, raised on the upper surface and hollowed on the under.

86. Keel-shaped, (*carinatum*), when on the under surface of a linear, lanceolate or oblong leaf, the place of the middle rib is formed like the keel of a ship.

B. *Compound Leaves.*

87. Compound, (*compositum*), when several leaves are supported by one footstalk. To this term belong Nos. 88, 92, 95, 96, 97. But when the leaf agrees with the above definition, although it should not come under any of the following kinds, it is still to be considered as a compound leaf.

88. Fingered, (*digitatum*), when the base of several leaves rests on the point of one footstalk, as in the horse-chesnut, Aesculus *hippocastanum*.

89. Binate, (*binatum*), when two leaves stand by their base on the top of one stalk; but if the two foliola of a binate leaf bend back in a horizontal direction, it is called a conjugate leaf, (*folium conjugatum*).

90. Bigeminate, (*bigeminatum*, *bigeminum*), when a divided leaf-stalk at each point bears two leaves, as in some species of Mimosa, fig. 217.

91. Trigeminate, (*trigeminatum* or *tergeminum*), when a divided leaf-stalk on each point bears two leaves, and on the principal stalk, where it divides,

there

there is a leaf at each side, as in the Mimosa *tergemina*, fig. 234.

92. Ternate, (*ternatum*), when three leaves are supported by one footstalk: as in the clover, Trifolium *pratense*, strawberry, Fragaria *vesca*.

93. Biternate, (*biternatum*, s. *duplicato-ternatum*), when a footstalk which separates into three at each point bears three leaves.

94. Triternate, (*triternatum* s. *triplicato-ternatum*), when a footstalk which separates into three is again divided at each point into three, and on each of these nine points bears three leaves, fig. 207.

95. Quinate, (*quinatum*), when five leaves are supported by one footstalk: this, it is true, has some affinity with No. 88, but varies on account of the number five, as in the other there are generally more leaves.

96. Pedate, (*pedatum* s. *ramosum*), when a leaf-stalk is divided, and in the middle where it divides there is a leafet, at both ends there is likewise a leafet, and on each side between the one in the middle and that on the end, another, or two or even three leaves. Such a leaf, therefore, consists of 5, 7, or 9 leafets that are all inserted on one side, as in the Helleborus *viridis*, *fœtidus* and *niger*, fig. 246.

97. Pinnated, (*pinnatum*), where on an undivided leaf-stalk there is a series of leafets on each side and on the same plane. Of this there are the following kinds.

α. Abruptly pinnate, (*pari-pinnatum* s. *abrupte-pinnatum*), when at the apex of a pinnated leaf there is no leafet, fig. 30.

β. Pinnate with an odd one, (*impari-pinnatum, s. pinnatum cum impari*), when at the apex of a pinnated leaf there is a leafet.

γ. Oppositely pinnate, (*opposite pinnatum*), when the leafets on a pinnated leaf stand opposite to one another.

δ. Alternately pinnate, (*alternatim pinnatum*), when the leafets on a pinnated leaf stand alternately, fig. 30.

ε. Interruptedly pinnate, (*interrupte pinnatum*), when in a pinnated leaf each pair of alternate leafets is smaller, fig. 8.

ζ. Jointedly pinnate, (*articulate pinnatum*), when between each pair of opposite pinnulæ or leafets the stem is furnished with a jointed edge, fig. 239.

η. Decursively pinnate, (*decussive pinnatum*), when from each particular pinnula a foliaceous appendage runs down to the following one, fig. 240.

θ. Decreasingly pinnate, (*pinnatum foliolis decrescentibus*), when the successive foliola on a pinnated leaf grow gradually smaller to the point, as in Vicia *sepium*.

98. Conjugately pinnated, (*conjugato-pinnatum*), when a leaf-stalk divides, and each part makes a pinnated leaf, fig. 222.

99. Digitato-pinnate, (*digitato-pinnatum*), when several simply pinnated leaves, from four to five, stand on the point of one stalk, as in Mimosa pudica, fig. 285.

100. Doubly pinnate, (*bipinnatum*, *duplicato-pinnatum*), when a leaf-stalk bears, on one plane on both sides, a number of leaf-stalks, of which each is a pinnated leaf, fig. 249.

101. Trebly pinnate, (*triplicato-pinnatum*, s. *tripinnatum*), when several doubly pinnated leaves are attached to the sides of a foot-stalk on one plane, fig. 247.

102. Doubly compound, (*decompositum*), when a divided leaf-stalk connects several leaves; of this kind are Nos. 90, 91, 93, 98, 99, 100. But the term *decompositum* is only used when the division of the leaf-stalk and of the pinnulæ is irregular, fig. 241.

103. Super-decompound, (*supra decompositum*), when a leaf-stalk, which is often divided, sustains several leaves; to this belong No. 94, 101. But then the term is used only when the divisions of the leafets are either more numerous or not so regular.

C. *In respect of the Place.*

104. Radical, (*radicale*), when a leaf springs from the root, as in the violet, Viola *odorata*. Sagittaria *sagittifolia*, fig. 44.

105. Seminal, (*seminale*), when a leaf grows out of the parts of the seed, as in the hemp, where, as soon as it springs, there appear two white bodies, which are the two halves of the seed, that change nto leaves.

106. Cauline, (*caulinum*), which is attached to the principal stem. The root-leaves and stem-leaves of a plant are often very different.

107. Rameous (*rameum*), when a leaf rises from the branches.

108. Axillary, (*axillare* v *subalare*), which stands at the origin of the branch.

109. Floral, (*florale*), which stands close by the flower, fig. 33.

D. *In respect of Substance.*

110. Membranaceous, (*membranaceum*), when both membranes of a leaf lie close upon one another without any pulpy substance between them, as in the leaves of most trees and plants.

111. Fleshy, (*carnosum*), when between the membranes there is much soft and pulpy substance, as in houseleek, Sempervivum *tectorum.*

112. Hollow, (*tubulosum*), when a somewhat fleshy and long leaf is internally hollow, as in the onion, Allium *Cepa.*

113. Cylindrical, (*teres*), when it is formed like a cylinder.

114. Compressed, (*compressum*), when a thick leaf is flat on both sides.

115. Two-edged, (*anceps*), when a compressed leaf is sharp on both edges.

116 Depressed, (*depressum*), when the upper surface of a fleshy leaf is pressed down, or as it were hollowed out.

117 Flat, (*planum*), when the upper surface of a thick leaf forms an even plane.

118. Gibbous, (*gibbosum* s. *gibbum*), when both surfaces are convex.

119. Scimitar-shaped, (*acinaciforme*), a two-edged

thick leaf, on one side sharp and arched, on the other, straight and broad.

120. Axe-shaped, (*dolabriforme*), when a fleshy leaf is compressed, circular on the upper part, convex on the one side, sharp-edged on the other, and cylindrical at the base, fig. 244.

121. Tongue-shaped, (*linguiforme*), when a long compressed leaf ends in a round point.

122. Three-sided, (*triquetrum*), when the leaf is bounded by three narrow sides, and is at the same time long.

123. Deltoid, (*deltoides*), when a thick leaf is bounded by three broad surfaces, and is at the some time ſhort, fig. 231.

124. Four-cornered, (*tetragonum*), when a leaf, long in proportion, is bounded by four narrow surfaces, as in the Pinus *nigra*.

125. Warty, (*verrucosum*), when short, fleshy leaves are truncated, and stand in thick heaps, as in some Euphorbia, fig. 228.

126. Hook-shaped, (*uncinatum*), when a fleshy leaf is flat above, compressed at the sides, and bent back at the point, fig. 230*.

E. *In respect of Situation and Position.*

127. Opposite, (*folia opposita*), § 13; No. 10; fig. 32.

128. Alternate, (*alterna*), § 13; No. 9; fig. 23.

129. Scattered, (*sparsa*), when the leaves stand thick on the stem, without any order.

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* All these leaves, from Nos. 111 to 126, are thick and fleshy; only Nos. 112, 122 and 124 are sometimes in certain plants membranaceous.

130. Crowded, (*conferta* s. *approximata*), when the leaves stand so close together that the stem cannot be seen.

131. Remote, (*remota*), when the leaves are separated on the stem by certain interstices.

132. Three together, (*terna*), when three leaves stand round the stem: there are sometimes four, five, six, seven, eight, &c. *quaterna*, *quina*, *sena*, *septena*, *octona*, &c.

133. Star-like, (*stellata* s. *verticillata*), when several leaves stand round the stem at certain distances, as in ladies bed-ſtraw, Galium, &c. fig. 29.

134. Tufted, (*fasciculata*), when a number of leaves stand on one point, as in the larch, Pinus *larix*, Celastrus *buxifolius*, fig. 14.

135. Two rowed, (*disticha*), when leaves are so placed on the stem that they stand on one plane, as in the pitch fir, Pinus *picea*, Lonicera *symphoricarpos*.

136. Decussated, (*decussata*), when the stem its whole length is set round with four rows of leaves, and at each branch, when one looks perpendicularly down upon it, the leaves seem to form a cross, as in Veronica *decussata*.

137. Imbricated, (*imbricata*), when one leaf lies over another as the tiles upon a roof, fig. 229. Of this there are the following kinds.

α. Bifariously imbricated, (*bifariam imbricata*), when the leaves are so laid upon one another that they form but two rows longitudinally on the stem.

β. *Trifariam imbricata*, three rows.

γ. *Quadrifariam imbricata*, *&c.* four rows, &c.

F. *In*

F. *In respect of Insertion.*

138. Petiolated, (*petiolatum*), when a leaf is furnished with a foot-stalk.

139. Palaceous, (*palaceum*), when the foot-stalk is attached to the margin.

140. Peltated, (*peltatum*), when the foot-stalk is inserted into the middle of the leaf, fig. 1.

141. Sessile, (*sessile*), when the leaf is attached to the stem without any foot-stalk, fig. 29.

142. Decurrent, (*decurrens*), when the foliaceous substance of a sessile leaf runs down along the stem.

143. Clasping the stem, (*amplexicaule*), when a sessile leaf is heart-shaped at the base, and with both lobes embraces the stem.

144. Connate, (*connatum*), when opposite, and sessile leaves are joined at their base.

N. A perfoliated leaf, (*folium perfoliatum*), is already described in § 13, No. 46.

G. *In respect of Position.*

145. Appressed, (*adpressum*), when the leaf turns up and lays its upper surface to the stem.

146. Erect, (*erectum* s. *semiverticale*), when the leaf is directed upwards, and makes, with the stem, a very acute angle.

147. Vertical, (*verticale*), which stands quite upright, and thus makes with the horizon a right angle.

148. Bent sideways, (*adversum*), when the margin of a vertical leaf is turned towards the stem.

149. Spreading, (*patens*), which goes off from the stem in an acute angle.

150 Bent in, (*inflexum* s. *incurvum*), when an upright leaf is bent in at its point towards the stem.

151. Oblique, (*obliquum*), when the base of the leaf stands upwards, and the point is turned towards the horizon, but the margin of the point towards the ground.

152. Horizontal, (*horizontale*), when the upper surface of the leaf makes with the stem a right angle.

153. Bent down, (*reclinatum* s. *reflexum*), when the leaf stands with its point bent towards the earth.

154 Bent back, (*revolutum*), when the leaf is bent outwards, and its point from the stem.

155. Hanging down, (*dependens*), when the base is turned to the zenith, and the point towards the ground.

156. Rooting, (*radicans*), when the leaf strikes roots.

157. Swimming, (*natans*), when the leaf swims on the surface of water, as in Nymphæa *alba*.

158. Immersed, (*demersum*), when the leaves are found under water.

§ 23.

In the descriptions of LEAVES, the following are still to be marked: When a leaf does not perfectly answer to the figure it comes nearest to, the word *sub* is to be used, e. g. *subcordatum*, *subovatum*, *sub-*

serratum, &c. a nearly heart-shaped leaf, an almost ovate leaf, a leaf somewhat serrated, &c. When the leaf answers the description, but seems to be inverted, that is, that the apex resembles what the base should be, and the base is like what the apex should be, we use the word *ob*, e. g. *obovatum*, fig. 14. *obcordatum*, *&c.*

With regard to the particular parts of leaves, we have still to notice,

1. The lobe, (*lobus*), the segment of a leaf which is round at the apex, as in Acer.

2. The segment, (*lacinia*), the segment of a leaf that runs into an angle at the point, and is uneven.

3. The little leaf, (*foliolum*), the little leaves that make part of a digitated, quinate, &c. leaf, are called *foliola* or leafets.

4. The leaf of a bi-pinnated leaf, (*pinna*), each simply pinnated leaf of a bi-pinnated leaf is called pinna.

5. The leafet of a pinnated leaf, (*pinnula*), means one of the leafets of which the pinnated leaf is composed.

6. Two-paired pinnated, (*pinnatum bijugum*), when the pinnated leaf has only two pair of opposite leaves, (*trijugum*), when it has three pair, (*quadrijugum*), when it has four pair, &c.

7. Angle, (*angulus*), respects the point of a lacinia or segment.

8. Indentation, (*sinus*), respects the hollow interstice between the segments of the leaf when it is round.

Each of these parts is, in accurate description, to be considered as a single leaf, in respect of surface, margin, apex, base*, &c.

§ 24.

To leaves belongs likewise the term FROND, (*frons*), which is peculiar to the palms, ferns and lichens. It is defined like the leaves, fig. 3, 15.

But the following terms are likewise applicable to lichens, though not to leaves.

1. Powdery, (*pulverulenta*), which consists of a quantity of fine dust or powder.

2. Crustaceous, (*crustacea*), which looks like a leaf, but consists of small crusts lying upon one another.

3. Star-like, (*stellata*), which spreads from the centre equally to all sides, fig. 3.

4. Leathery, (*coricea*), which is of a firm tough substance, fig. 226.

5. Thread-like, (*filamentosa*), which is composed of fine threads.

In the palms two kinds of fronds are distinguished.

1. Fan-like, (*flabelliformis*); this is more or less of a circular form; and from the point to the base

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[*] In a simply pinnated leaf each leafet is called *pinnula*, or sometimes *foliolum;* and only in doubly pinnated leaves do we observe the differences marked above in Nos. 4 and 5. Linnæus, in some species of the genus Mimosa which have doubly pinnated leaves, calls each simply pinnated leaf of a doubly pinnated one, *pinna partialis*, and each leafet, *pinna propria*, or simply *pinna*.

is divided into numerous small lobes which lie close upon one another, and between which there is often a thread.

2. Pinnated, (*pinnata*), a frons which is formed like a pinnated leaf, § 22. No. 97.

§ 25.

The leaves of mosses are in their structure not different from those of plants. No compound leaves have been observed in them, and, in very few, deep incisures. The cloathing of the leaves is either smooth (*glabrum*), or hairy (*pilosum*), and then there is commonly only a hair at the point of each leaf. Cartilaginous or succulent leaves have not yet been discovered among them. The leaves are generally sessile; none with foot-stalks, except in one species, have yet been found.

The leaves of the Musci hepatici are distinguished by the same terms with other plants, except compound leaves, which are wanting to them. When the leaves of the Musci hepatici et frondosi have very deep laciniæ, they are not called *folia* but *frondes*.

§ 26.

Under the name of Props, (*fulcra*), we understand those parts which differ from the stem, leaves, root and flower: but serve for keeping the plant erect, for its clothing, defence, or other purposes. Such are the following: Ramentum, Bractea, Vagina, Spatha, Ochrea, Ascidium, Ampulla, Ligula, Involucrum, Volva, Annulus, Pileus, Indusium, Cirrhus, Gemma, Bulbus, Propago, Gongylus, Glandula, Spina, Aculeus, Arista, Pilus.

§ 27.

STIPULES, (*Stipulæ*), are small leaves that appear on the stem in place of the foot-stalks of the leaves. They are sometimes of a quite different shape from the proper leaves, but sometimes no way different, except in situation and size. They may be distinguished by the following terms.

1. Double, (*geminæ*), when two are present, which always stand opposite ; fig. 27, 30, 32.

2. Solitary, (*solitariæ*), when a single stipule stands upon one side of the leaf footstalk.

3. Lateral, (*laterales*), when they stand at the origin of the petiolus, fig 27, 30, 32.

4 Under the petiolus, (*extrafoliaceæ*), when they stand somewhat under the origin of the petiolus.

5. Above the petiolus, (*intrafoliaceæ*), when they stand somewhat above the originof the petiolus.

6. Opposite to the petiole, (*oppositifolia*), when in leaves placed alternately these stipulæ stand in the place of the origin of the petiole, but on the other side of the stem.

7. Caducous, (*caducæ*), when they fall off soon after their evolution, as in the hazle, Corylus *Avellana*.

8. Deciduous, (*deciduæ*), when they fall off, a short while before the leaves, or a considerable time after their appearance.

9. Abiding, (*persistentes*), when they fall or wither along with the leaves, or after them*.

§ 28.

The RAMENT (*ramentum*), is a small, often bristle-shaped leafet, that is oblong, thin, and more or less of a brown colour; sometimes placed, like the stipula, in the angles of the petiole, but sometimes likewise, without any order, on the stem. It appears on all trees when their buds open, and falls soon after. On the oak, fig. 289. it stands like the stipulæ; on the Scots fir, Pinus *sylvestris*, it is soon dispersed.

When the stem of a plant is covered with fine dry scales, that have the appearance of the Ramentum, it is properly called a ramentaceous stem, (*caulis ramentaceus*).

§ 29.

The FLORAL LEAVES, (*bracteæ*), are leaves that stand near or between the flowers, and in general are of a different shape and colour from the other leaves, fig. 33, 44. They differ in respect of duration like the stipulæ, that is, they are either caducous, deciduous or persistent. The lime tree, Tilia *europæa*, affords an excellent example of the Bracteæ. When they are of another colour than green, they are said to be coloured, (*coloratæ*). On the top of many flowers there are several of these bracteæ, in which case they are called a tuft, (*coma.*) Examples of this we have in the crown imperial, Fritillaria *imperialis*, the pine apple, Bromelia *Ananas*, &c.

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* In form, the stipulæ are very different, and what we have said with regard to that of the proper leaves may be applied to them, in respect of outline, apex, base, margin and surface. They are in general sessile, (*sessiles*), seldom connate, (*connatae*), and still seldomer petiolated, (*petiolatae* s. *pedicellatae*). They are often marked with a dark brown spot, as in Vicia *sativa*, and then they are called *sphacelatae*.

§ 30.

The SHEATH, (*vagina*), is the prolongation of a leaf, which rolls itself round the stem, and thus forms a cylinder, to the opening of which the leaf is attached, as in Polygonum, and all the Grasses. When this sheath is very short, and on the upper part of it there is nothing remarkable, it is called a sheathing leaf, (*folium vaginatum*). The vagina is also described according to its surface, § 6.

§ 31.

The SPATHE, (*spatha*), is an oblong leaf, which surrounds the stem with its base, and serves for a covering to flowers before they blow; but after the flowers are unfolded it stands at a greater or less distance from them. It is common to all palms, to most lilies and arums. Of it there are the following kinds.

1. Univalve, (*univalvis*), when it consists but of one leaf, as in Arum *maculatum*, fig. 41.
2. Bivalve, (*bivalvis*), when two leaves stand opposite

posite to each other, as in the fresh water soldier, Stratiotes *aloides*.

3. Vague, (*vaga*), when there is not only a large common vagina, but likewise separate vaginæ for each particular division of the flower stem, and for each particular flower.

4. Halved, (*dimidiata*), the same with univalve, only the flowers are covered but on one side.

5. One-flowered, two-flowered, &c. many-flowered (*uni-bi-multiflora*), when it includes one or more flowers.

6. Withering, (*marcescens*), when it withers at flowering, or a short while before.

7. Permanent, (*persistens*), when it remains unchanged till the fruit ripens.

§ 32.

The ROLL, (*ochrea*), is a leaf-like body, which surrounds the branches of the flower-stalk in some grasses, in the manner of a cylindrical sheath. This is chiefly to be observed in the genus Cyperus, fig. 291. The margin of it is various, and affords the following diversities.

1. Truncated, (*truncata*), when the margin is even, as if it had been cut off.

2. Oblique, (*obliqua*), when the margin is somewhat lengthened out on one side.

3. Foliaceous, (*foliacea*), when the roll ends in a short, linear, or subulated leaf.

It is further distinguished according to its surface, as in § 6.

§ 33. The

§ 33.

The BOTTLE, (*ascidium*), is a particular foliaceous body that is cylindrical and hollow, and often has its mouth furnished with a complete cover, which opens occasionally. This body generally contains pure water. It is either sitting, (*sessile*), or supported on a foot-stalk, (*petiolatum*), and is situated at the extremity of a leaf. The latter is found in the Nepenthes *distillatoria*, fig. 28, the former in Sarracenia.

In two genera, namely the Ascium and Ruyschia, there are bracteæ which have the appearance of an Ascidium, and are therefore called *Bracteæ ascidiformes*, fig. 117, 121.

§ 34.

The BLADDER, (*ampulla*), is a round, hollow, closed body, that is found at the roots of some water-plants, as Utricularia, Aldrovanda, &c. fig. 288.

§ 35.

The STRAP, (*ligula*), is a membranaceous, small, transparent leafet, which is situated on the margin of the vagina, and at the base of the leaf. It is only proper to the Grasses, fig. 26. It affords the following varieties.

1. Intire, (*integra*), when it has no segments.
2. Bifid, (*bifida*), when it is divided at the apex.
3. Torn, (*lacera*), when it is irregularly, as it were, torn on the margin.

4. Fringed, (*ciliata*), when the margin is set with short, projecting hairs.

5. Truncated, (*truncata*), when the upper part terminates in a transverse line.

6. Pointed, (*acuta*), that has a short acute point.

7. Acuminated, (*acuminata*), that has a long projecting point.

8. Very short, (*decurrens*), that is hardly visible, and runs down the inside of the vagina.

§ 36.

The INVOLUCRE, (*involucrum*), consists of several leaves that differ in form from the proper leaves of the plant; they surround one or several flowers and enclose them before they unfold. The involucrum is particularly found in the umbelliferous plants, § 59. There are several varieties of it, *viz.*

1. Common, (*universale*), which incloses all the flower-stalks, fig. 36.

3. Halved, (*dimidiatum*), which surrounds only half of the stem.

4. Hanging, (*dependens*), when all the leafets hang down, as in Aethusa *Cynapium.*

5. Two, three, four, or many-leaved, (*di*, *tri*, *tetra*, or *polyphyllum*), that consists of two or more leafets*.

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* The Involucrum has sometimes the appearance of a Calyx, § 67, and then is said to be calyciform, (*calyciforme*), as in the liverwort, Anemone *hepatica*. The flower-stalk, § 17, in some species of this genus, as in Anemone *pratensis*, is surrounded by an Involucrum, and is then called *pedunculus involucratus.*

§ 37.

The FUNGI differ so much in external appearance from other plants, that their parts cannot be compared with them. The principal parts are the Volva, Annulus and Pileus.

The WRAPPER, (*volva*), is a thick, and, in general, fleshy membrane, that envelopes the fungus in its young and unexpanded state, and when it is full grown remains close upon the ground. It has been considered as a part of the flower, but erroneously. In some fungi, as in the puff-ball, Lycoperdon *stellatum*, fig. 7. it is deeply cut, and is then called star-like, (*stellata*); in others it is double, (*duplex*).

§ 38.

The RING, (*annulus*), is a thin membrane that is attached to the stalk, and encompasses it like a ring. When the fungus is young, this membrane is connected with the pileus, but afterwards separates from it. There are the following varieties of the annulus.

1. Upright, (*erectus*), when the ring is fixed below, but free above, fig. 4.

2. Inverted, (*inversus*), when the ring is fixed above, but free below, so that it is bell-shaped and hangs down, as in Agaricus *mappa*.

3. Sitting, (*sessilis*), when, as in the above species, it is always attached by one side.

4. Moveable, (*mobilis*), when the ring can be pushed up and down, as in Agaricus *antiquatus*.

5. Permanent, (*persistens*), when it is found during the whole existence of the fungus.

6. Fugacious, (*fugax*), when at the perfect developement of the fungus the ring disappears.

7. Cobweb-like, (*arachnoideus*), when the ring is composed of a very white web. Rings of this kind are often very evanescent*.

§ 39.

The CAP, (*pileus*), is the top of the fungus, in general shaped like a plate or bonnet, and supported by the stalk, (*stipes*). In this body are situated the organs of generation. There are the following kinds of it.

1. Flat, (*planus*), forming a plane expansion, fig. 223, 224 and 225.

2. Round, (*convexus*), which is convex above.

3. Hollow, (*concavus*), where there is a depression on the upper surface, fig. 6.

4. Bossed, (*umbonatus*), when there is a prominent point in the centre, fig. 4.

5. Bell-shaped, (*campanulatus*), when it is very convex above, and spreads wide below like a bell, as in Agaricus *fimetarius*.

6. Viscid, (*viscidus*), when the upper surface is covered with a clammy exudation.

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* The Ring is properly a prolongation of the membrane of the pileus, part of which remains upon the stalk; but in some fungi it does not separate from the rim of the pileus, but from the stalk, and remains attached to the pileus, in longer or shorter portions according to the species.

7. Scaly, (*squamosus*), when it is covered above with many imbricated scales of a different colour from its own, as in Agaricus *muscarius*.

8. Squarrose, (*squarrosus*), when the scales stand up from the surface, fig. 4.

9. Halved, (*dimidiatus*), when it forms only half the figure of a plate, and appears to have one side taken off; as in Hydnum *auriscalpium*.

10. Stipitate, (*stipitatus*), when it is supported by a stalk, § 19.

11. Sitting, (*sessilis* s. *acaulis*), when it is not supported by a stalk.

The pileus of the fungi has likewise parts peculiar to it, which must be carsfully observed, such as the *Umbo*, *Lamella*, *Porus*, *Aculeus* s. *Echinus* and *Papillæ*.

- α. The boss, (*umbo*), is the centre of the pileus, which is somewhat raised. This umbo is often present, even in a concave pileus.
- β. The gills, (*lamellæ*), are the thin foliaceous membranes on the underside of the mushroom. The gills contain the capsules of the seed, and are peculiar to the genus Agaricus. fig: 225. The Lamellæ are
  - *a*. Equal, (*æquales*), when all the gills reach from the stalk to the margin.
  - *b*. Unequal, (*inæquales* s. *interruptæ*), when some reach from the stalk to the rim, while others go only half way, either from the stalk or from the rim.

This inequality of the gills is distinguished into

- *a*. Two-rowed, (*biseriales*), when a long and short gill are alternate.

b. Three-

b. Three-rowed, (*triseriales*), when two short gills stand between two long ones.

c. Branched, (*ramosæ*), when several gills unite in one.

d. Decurrent, (*decurrentes*), when the gills run down the stalk.

e. Venous, (*venosæ*), when the gills are so small that they appear to be only raised veins, as in Agaricus *chantarellus*.

γ. The pores, (*pori*), when on the under side of the pileus there are very small holes, as if made with the point of a needle, fig. 223. These are peculiar to the Boleti.

δ. The prickles, (*aculei* s. *echini*), are raised projecting points, in which, as in the pores, are contained the organs of generation. They are peculiar to the genus Hydnum, fig. 224.

ε. The warts, (*papillæ*), are small, round protuberances that appear on the under surface, and likewise contain the organs of generation*.

§ 40.

The COVER, (*indusium*), in the Filices is a thin membrane which covers the seeds or the flowers.

It presents the following kinds:

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* Some fungi have a very different appearance; some want the pileus, or are of a singular form without stalk. Their figure must therefore be described, as whether they are round, (*globosus*), fig. 7, cup-shaped (*cyathiformis* s. *scyphiformis*), fig. 284, &c.

1. Flat, (*planum*), when the thin membrane lies flat upon the seeds, as in Polypodium.

2. Peltated, (*peltatum*), when this thin membrane is circular; and below, in the middle, is attached to the seeds by a small thread.

3. Horn-like, (*corniculatum*), when this thin membrane is cylindrical and hollow, and incloses the flowers and seeds, as in Equisetum. In fig. 11, there are four of these horn-like indusia to be observed.*

§ 41.

The TENDRIL, (*cirrhus*), is a thread-like body, which serves for attaching plants to some support. Climbing plants, (*vegetabilia scandentia*), are furnished with these. They are in general spiral, as in the Vine, Vitis *vinifera*, fig. 27. The species are as follows:

1. Axillary, (*axillares*), when they rise from the axillæ of the leaves, fig. 27.

2. Foliar, (*foliares*), when they spring out of the points of the leaves.

3. Petiolar, (*petiolares*), when the cirrhi stand on the point of the common foot-stalk of a compound leaf.

4. Peduncular, (*pedunculares*), when they rise out of the foot-stalk of the flower.

5. Simple, (*simplex*), when a cirrhus is not divided.

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* The celebrated Dr. Smith of London has well distinguished the genera of the Filices by the way in which the indusium bursts.

6. Two, three, many-branched. (*bi*, *tri*, *multifidus*), when a cirrhus branches out into two, three, or more parts.

7. Convolute, (*convolutus*), when the cirrhus regularly winds itself round a prop.

8. Revolute, (*revolutus*), when the cirrhus winds itself irregularly, sometimes to this side, sometimes to that*.

§ 42.

The BUD, (*gemma*), is that part of a plant which contains the embryo of the leaves and flowers. All plants are not furnished with buds, but only such as grow in cold climates. They either inclose leaves alone, (*foliiferæ*); or leaves and flowers in separate buds, (*foliiferæ et floriferæ distinctæ*); or leaves and female flowers, (*foliiferæ et floriferæ femineæ*); or leaves and male flowers, (*foliiferæ et floriferæ masculæ*); or leaves and hermaphrodite flowers, (*foliiferæ et floriferæ hermaphroditæ*); or lastly, leaves and flowers in one bud, (*foliifero-floriferæ*). The opening of the buds, and the appearance of the leaves, is called Foliation, (*foliatio*). This is occasioned by the fall of the outer covers, which consist of small imbricated scales. In plants that have no buds, the foliation takes place immediately from the bark. In different plants at foliation, the young leaves are variously folded up. When an opening bud is cut over horizontally, the following varieties appear:

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* When a simple leaf has a cirrhus at its apex, it is called *folium cirrhosum*, as in Gloriosa *superba*, Flagellaria *indica*, &c. When a pinnated leaf has a cirrhus at its apex, as in most leguminous plants, it is called *folium pinnatum cirrhosum*, No. 3.

1. Involute, (*involuta*), when the edges of the leaves are turned in, as in the hop, Humulus *lupulus* fig. 251, 259, 260.

2. Revolute, (*revoluta*), when the edges of the leaves are rolled outwards, as in the willows, (*Salices*), fig. 252, 262.

3. Obvolute, (*obvoluta*), when two simply closed leaves, without being rolled, embrace the half of each other, as in sage, Salvia *officinalis*, fig. 256.

4. Convolute, (*convoluta*), when the leaves are rolled up spirally, as in the plumb, Prunus *domestica*, apricot, Prunus *armeniaca*, fig. 250, 258.

5. Riding, (*equitans*), when several leaves which lie parallel, embrace the whole of one another, as in the lilac, Syringa *vulgaris*, fig. 254, 255, 263, 264.

6. Conduplicate, (*conduplicata*), when the sides of the leaves lie parallel to one another, as in the beech, Fagus *sylvatica*, fig. 253.

7. Plaited, (*plicata*), when the leaves are regularly folded, as in the birch, Betula *alba*, fig. 257.

8. Bent down, (*reclinata*), when the points of the young leaves hang down, as in Arum, Aconitum.

9. Circinal, (*circinata*), when the whole leaf, from the point to the base, is rolled up, so that the outside is within, and the inside without, as in all the Filices, fig. 15.

N. When the leaves are opposite, the figure is often doubled, as in fig. 258, 259, 268, 262.

§ 43. The

§ 43.

The BULB, (*bulbus*), is, properly speaking, a bud under ground. Of this there are the following kinds:

1. Scaly, (*squamosus*), composed of scales, as in the bulbiferous lily, Lilium *bulbiferum*, fig. 19.

2. Coated, (*tunicatus*), consisting of concentric coats or skins, as in the common onion, Alium *Cepa*, fig. 17.

3. Net-like, (*reticulatus*), consisting of concentric coats, like close net-work, as in the Allium *victoriale*.

4. Solid, (*solidus*), consisting of a solid substance, as in the Colchicum *autumnale*.

5. Lateral, (*lateralis*), where the leaves do not, as is commonly the case, rise from the middle, but from the side; as in Allium *ampeloprasum*.

6. Doubled, (*duplicatus*), when two are always found together, as in Fritillaria *pyrenaica*.

7. Compound, (*compositus*), when several bulbs stand together, as in Allium *nigrum**.

§ 44.

The MOSS-BUD, (*propago*), is a roundish or longish body, proceeding from the mother plant, and becoming itself a new one, as in the mosses. Linnæus considers this as the seed. In the Musci hepatici this organ is spherical. The Marchantia bears a small cup, (*scyphus*), in which the propago is contained.

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* The bulb is likewise described according to its shape as round, oval, &c. See in § 11. the difference between a tuberous root and a bulb.

§ 45.

The KNOT, (*Gongylus*), is a round, hard body, which falls off upon the death of the mother-plant, and becomes a new one. An example of this is observed in the Fuci.

§ 46.

A GLAND, (*glandula*), is a round body that serves for transpiration and secretion. The glands are generally situated on the leaves or stems. They are,

1. Sitting, (*sessiles*), when they sit close upon the leaf, as in Cassia *marylandica*.
2. Petiolate, (*petiolatæ*), when they are raised upon a little stalk, as in the sun-dew, Drosera.

§ 47.

A THORN, (*spina*), is a strong projecting spine, that rises in the interior of the plant, and therefore does not come off with the bark; as in the sloe, Prunus *spinosa*. The kinds are,

1. Terminal, (*terminalis*), when it is situated at the point of a branch.
2. Axillary, (*axillaris*), when it is situated at the side or origin of the branch.
3. Simple, (*simplex*), consisting of a single thorn.
4. Divided, (*divisa*), divided at the point.

5. Branched, (*ramosa*), separated into several branches*.

§ 48.

A PRICKLE, (*aculcus*), is a persistent production that issues from the bark, and comes away with it, as in the rose, Rosa *centifolia*. Of it there are the following kinds:

1. Straight, (*recti*), when the prickles are not bent.

2. Incurved, (*incurvi*), when they are curved upwards.

3. Recurved, (*recurvi*), when they are bent towards the ground.

4. Solitary, (*solitarii*), when they stand at a distance.

5. Doubled, (*geminati*), when two prickles stand together.

6. Palmated, (*palmati*), when several hang together, as in the barberry, Berberis *vulgaris*.

§ 49.

The AWN, (*Arista*), is a pointed beard, that sits on the flower of the grasses. It is,

1. Naked, (*nuda*), not hairy, fig. 101, 103.

2. Feathered, (*plumosa*), set with fine white hairs, as in the Stipa *pennata*.

Straight, (*recta*), when quite straight, fig. 101, 103.

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* The origin of the thorn will be more particularly considered afterwards in the Physiology.

4. Geniculated, (*geniculata*), that has a joint in the middle by which it is bent, as in the common oat, Avena *sativa*.

5. Bent, (*recurvata*), when bent in the form of a bow.

6. Twisted, (*tortilis*), when it is spirally twisted, or forms a serpentine line.

7. Terminal, (*terminalis*), when situated on the point of the glume. § 65.

8. Dorsal, (*dorsalis*), when inserted behind the apex or on the back of the glume.

§ 50.

The HAIR, (*pilus*), is a fine slender body, sometimes long, sometimes short; hairs are organs of transpiration, and serve for the covering of plants. The various divisions of hairs we have already mentioned in § 6. The kinds are,

1. Simple, (*simplices*), that are not divided, but are of an equal filiform appearance.

2. Awl-shaped, (*subulati*), short, strong hairs, that are thickest at the root, as those on the borage, Borago *officinalis*.

3. Needle-shaped, (*aciculares*), very sharp pointed like the last, but at their base there is an enlargement.

4. Bulbous, (*bulbosi*), that have a round bulb-like appendage at the base, as in Centaurea *Jacea*.

3, Hook-shaped, (*uncinati*), that are bent like a hook, as in Scabiosa *succisa*, and various grasses.

6. Knobbed, (*nodosi*), that have regular knobs with interstices between them.

7. Articulated, (*articulati*), divided into regular and somewhat contracted members, so as to have the appearance of the antennæ of some insects, as in Veronica *aphylla*, Lamium *purpureum*, Sonchus *oleraceus*.

8. Denticulated, (*denticulati*), set on one side as it were with small teeth.

9. Pubescent, (*pubescentes*), covered with very minute hairs, as in Hieracium *pilosella*.

10. Plumose, (*plumosi*), that are thickly covered with long and very fine hairs, so that they resemble a feather, as in Hieracium *undulatum*.

11. Forked, (*furcati*), that at the point are divided like a fork, as in the Apargia *hispida*.

12. Branched, (*ramosi*), that divide irregularly into branches, as in the gooseberry, Ribes *grossularia*.

13. Stellated, (*stellati*), when several hairs rise from one root, press close upon one another, and take the appearance of a star, as in Alyssum *montanum*, and various species of Solanum.

The hair is still further distinguished, according to its rigidity and point.

a. Hair, (*pilus*), which is straight with some degree of stiffness.

b. Wool, (*lana*), which is crooked and soft.

c. Fine hair, (*villus*), very fine and soft.

d. Bristle, (*striga*), that is very stiff.

e. Hook, (*hamus*), that is stiff, and hooked at the point.

f. Double hook, (*glochis*), that is stiff, divided at the point, and bent back towards both sides*.

§ 51.

Before we proceed to the description of the particular parts of the flower, it is necssary to treat of the flower-stem, or, in other words, of the mode of flowering or inflorescence, (*inflorescentia*). The following kinds of inflorescence have been remarked: The Whirl (*verticillus*), the Head (*capitulum*), the Ear (*spicula*), the Spike (*spica*), the Raceme (*racemus*), the *Corymbus*, the *Fasciculus*, the Umbel, (*umbella*), the Cyme (*cyma*), the Panicle (*panicula*), the Thyrse (*thyrsus*), the *Spadix*, and the Catkin (*amentum*).

§ 52.

A WHIRL, (*verticillus*), consists of several flowers that encircle the stem, and stand uncovered at intervals upon it. Of this there are the following kinds.

1. Sitting, (*sessilis*), when all the flowers sit close to the stem without foot-stalks, as in the field-mint, Mentha *arvensis*.

2. With a foot-stalk, (*pedunculatus*), when the flowers are furnished with short foot-stalks.

3. Half, (*dimidiatus*), when the flowers surround

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* The various form of the hair here described is proper to all the parts of a plant, and is only to be observed by a magnifying glass.

only the half of the stalk, as in balm, Melissa *officinalis*.

4. Close, (*confertus*), when one whirl stands close above another.

5. Distant, (*distans*), when the whirls stand at a distance from one another.

6. Naked, (*nudus*), when no leaves or bracteæ stand near the whirl.

7. Furnished with bracteæ, (*bracteatus*), when there are floral leaves or bracteæ about the whirl.

8. Six, eight, ten, or many-flowered, (*sex*, *octo*, *decem*, s. *multiflorus*), when the whirl consists of many flowers.

§ 53.

A HEAD, (*capitulum*), is a number of flowers standing thick upon one stalk so as to form a round head. The flowers have either foot-stalks or sit close. The following are varieties of this:

1. Spherical, (*globosum*, *sphæricum*), when the flowers have a perfectly round form, as in the Gomphrena *globosa*, fig. 199.

2. Roundish, (*subrotundum*), when the head of flowers is nearly round, but where the length exceeds the breadth, as in clover, Trifolium *pratense*.

3. Conical, (*conicum*), when the head is long, drawing towards a point, as in Trifolium *montanum*.

4. Hemispherical, (*dimidiatum*, s. *hemisphæricum*), when the head is round on one side and flat on the other.

5. Leafy, (*foliosum*), when the head is surrounded with leaves.

6. Naked, (*nudum*), when it is devoid of leaves.

7. Standing on the point, (*terminalis*), when it stands on the top of the stem.

8. Axillary, (*axillaris*), standing in the angles of the leaves*.

§ 54.

The EAR, (*spicula* s. *locusta*), is peculiar to Grasses, and consists of a number of flowers which sit on one stalk, and are furnished but with one calyx. It is generally denominated from the number of flowers it contains.

1. Oneflowered, (*uniflora*), that contains but one flower, as in Agrostis.

2. Two-flowered, (*biflora*), having two flowers, as in Aira.

3. Three-flowered, (*triflora*), &c.

4. Many-flowered, (*multiflora*), that contains many flowers, fig. 93, 101.

§ 55.

The SPIKE, (*spica*), is a number of flowers that surround one simple straight principal stem without any foot-stalk, as in lavender, Lavendula *spica*, and many others. The kinds are,

1. Glomerate, (*glomerata*), when the spike consists of a spherical collection of flowers.

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* The Glomerule, (*glomerulus*), is properly a small head of a very small flower, that in general appears in the angles of the leaves, as in Amaranthus.

2. Interrupted, (*interrupta*), when the flowers upon the spike are interrupted by naked interstices.

3. Verticillated, (*verticillata*), when the flowers, leaving naked interstices on the spike, appear on that account to be placed in whirls.

4. Imbricated, (*imbricata*), when the flowers stand so thick together that one lies upon another.

5. Distichous, (*disticha*), when the flowers are arranged on the spike in two rows.

6. One-rowed, (*secunda*), when the flowers are all arranged on one side of the spike, so that the other side is naked.

7. Cylindrical, (*cylindrica*), when the spike is equally covered with flowers both above and below.

8. Linear, (*linearis*), that is very slender, and of equal thickness.

9. Ovate, (*ovata*), that is thick above, more slender below, and appears of an oval form.

10. Ventricose, (*ventricosa*), thick in the middle, and slender at both extremities.

11. Leafy, (*foliosa*), having leaves between the flowers.

12. Comose, (*comosa*), having leaves at the apex.

13. Fringed, (*ciliata*), having hairs between the flowers.

14. Simple, (*simplex*), without branches, fig. 277.

15. Branched or compound, (*ramosa* vel *composita*), when several spikes stand on one branched or divided stalk.

16. Conjugate, (*conjugata*), when two spikes, standing on one stalk, unite at the base.

17. Bundled, (*fasciculata*), when several spikes, standing on one foot-stalk, unite at the base.

18. Terminal, (*terminalis*), standing on the apex of the stalk or branch.

19. Axillary, (*axillaris*), standing in the angles at the origin of the leaves.

20. Lateral, (*lateralis*), standing on the wood of the former year, that is, on the place now destitute of leaves.

§ 56.

The RACEME, (*racemus*), that sort of peduncle to which several pedunculated flowers are attached, nearly of equal length, or at least where the lowest flower-stalks are little longer than the upper. Here follow the different kinds of Raceme.

1. One-sided, (*unilateralis*), when only one side of the stem is set with flowers.

2. One-rowed, (*secunda*), when flower-stems are situated round the principal stem, but the flowers themselves are directed only to one side.

3. Limber, (*laxus*), when the raceme is very pliant or flexible.

4. Stiff, (*strictus*), when the raceme does not bend.

5. Simple, (*simplex*), when it is unbranched, fig. 278.

6. Compound, (*compositus*), when several single racemes unite on one stem.

7. Conjugate, (*conjugatus*), when two racemes, standing on one stem, unite at the base.

8. Naked, (*nudus*), without leaves or bracteæ.

9. Foliate, (*foliatus*), set with leaves or bracteæ.

10. Erect, (*erectus*), standing upright.

11. Straight, (*rectus*), straight without bending.

12. Cernuous, (*cernuus*), when the apex of the raceme is bent downwards.

13. Nodding, (*nutans*), when the half of the raceme is bent downwards.

14. Hanging, (*pendulus*), when the raceme hangs down perpendicularly.

§ 57.

The CORYMB, (*corymbus*), is, properly speaking, an erect racemus, the lower flower-stalks of which are either branched or simple, but always so much produced as to be of equal height with the uppermost, fig. 25, 266.

§ 58.

The FASCICLE, or bundle, (*fasciculus*), is a number of simple foot-stalks of equal height, which arise, not from one point, but from several. The Fasciculus differs from the Corymbus in its short flower-stalks, and in their not being dispersed upon a long stem. From the Umbel it differs in that the flowers do not arise from one point. From the Cyma it differs in that the flower-stalks are not branched. As an example of the Fasciculus may be quoted Dianthus *carthusianorum*.

§ 59.

The UMBEL, (*umbella*), consists of a number of flower-stalks of equal length that rise from the point.

In an Umbel the flower-stalks are called rays, (*radii*). There are the following varieties of the Umbel.

1. Simple, (*simplex*), when the rays bear but one flower.

2. Compound, (*composita*), when each ray of the umbel supports a simple umbel, fig. 36. The rays which support the simple umbels are called the universal or general umbel, (*umbella universalis*). The simple umbels are called the particular or partial umbels, (*umbella partialis* s. *umbellula*).

3. Sitting, (*sessilis*), when the umbel has no stalk.

4. Pedunculated, (*pedunculata*), when it is furnished with a stalk.

5. Close, (*conferta*), when the rays of the umbel stand so near one another that the whole umbel becomes very thick and close.

6. Distant, (*rara*), when the rays stand wide.

7. Poor, (*depauperata*), when the umbel has but few flowers.

8. Convex, (*convexa*), when the middle rays are high, but stand thick, so that the whole form a globular figure.

9. Flat, (*plana*), when the rays being of equal length, the flowers form a flat surface.

§ 60.

The CYME, (*cyma*), consists of a number of branched flower-stalks, with irregular branches, and not rising from one point. It has considerable resemblance to the Umbel. Examples of it are found in the elder, Sambucus *nigra*, and the guelder rose, Viburnum *opulus*.

§ 61.

The PANICLE, (*panicula*), consists of a number of flowers that stand on unequally divided branches, and on a long peduncle, fig. 34. The kinds are,

1. Simple, (*simplex*), that has only undivided side-branches.

2. Branched, (*ramosa*), when the branches are again branched.

3. Much branched, (*ramosissima*), when the side-branches are much divided.

4. Spreading, (*patentissima*), when the branches stand wide from one another, and spread out on all sides.

5. Crowded, (*coarctata*), when the branches stand very close together.

6. One-rowed, (*secunda*), when the branches incline all to one side.

§ 62.

The THYRSE, (*thyrsus*), it a condensed panicle, whose branches are so thick that the whole has an oval form, as in the flower of the Privet, Ligustrum *vulgare*.

§ 63.

The SPADIX is peculiar to the palms, and some plants allied to the genus Arum. All flower-stalks that are contained in a vagina, are called Spadix. This organ is sometimes formed like a spike, a racemus, or panicle, and from these it takes its name, fig, 41, 42.

§ 64. The

§ 64.

The CATKIN, (*amentum* s. *julus*), is a long and always simple stem, which is thickly covered with scales, under which are the flowers or parts of the flower, fig. 37. Examples of this are found in the willows (*Salices*), hazle, Corylus *avellana*, &c.

1. Cylindrical, (*cylindricum*), which is equally thick above and below.

2. Attenuated, (*attenuatum*), which grows thinner and thinner to the point.

3. Slender, (*gracile*), which is long, but has few scales, and also is slender in proportion to its length.

4. Ovate, (*ovatum*), which is thick below and round, but grows gradually more slender to the point.

§ 65.

In Mosses, the flowers are of a particular form, and there are the following different modes of inflorescence, viz. *Flos gemmiformis*, *flos capituliformis*, *flos disciformis*.

1. The flower formed like a bud, (*flos gemmiformis*), is commonly seated between the leaves of the Moss: it has, with the assistance of a moderate magnifying glass, or sometimes with the naked eye, the appearance of a swollen bud.

2. The flower formed like a capitulum, (*flos capituliformis*), is a spherical, foliaceous substance which in Mosses appears raised on a peduncle, and is easily distinguished from the fruit, fig. 138.

3. The flower formed like a star, (*flos disciformis*), is a body seated at the top of the stem of mosses; it is flat, and furnished with broad leaves: it is conspicuous on the common polytrichum, Polytrichum *commune*, fig. 142.

§ 66.

The coloured part which distinguishes itself by its outward appearance, which precedes the fruit, and contains the necessary organs of generation, is called the FLOWER, (*flos*). It is composed of sundry parts, *viz*, the *Calyx*, *Corolla*, *Nectarium*, *Stamina* and *Pistillum*.

The three first parts are not essential parts of the flower, but the two last are indispensable in every flower.

§ 67.

The CALYX is a general name for all the little leaves or envelopes, that are commonly of a green colour, and surround the flower on the outside. The following are species of it: *Perianthium*, *Gluma*, *Anthodium*, *Squama*, and *Pappus*.

§ 68.

The PERIANTH, (*Perianthium*), is that species of Calyx which immediately incloses a flower. It is,

1. Abiding, (*persistens*), remaining after the flower falls off, as in the henbane, Hyoscyamus *niger*.

2. Deciduous, (*deciduum*), that falls off at the same time with the flower, as in the lime tree, Tilia *europæa*.

3. Withering, (*marcescens*), that withers after the flower, but still remains for some time, and at last drops off, as in the apricot, Prunus *Armeniaca*.

4. Caducous, (*caducum*), that falls off before the flower, as in the poppy, Papaver *somniferum*.

5. Simple, (*simplex*).

6. Double, (*duplex*), when a double perianthium encloses the flower, as in the strawberry, Fragaria *vesca*, mallow, Malva *rotundifolia*, fig. 23, 57.

7. One-leaved, (*monophyllum*), when the perianthium consists of one leaf, that is, it may be divided into equal or unequal laciniæ, but all of them are connected at the base, fig. 49, 50, 53, 72, 73, 110.

8. Two, three, four, five-leaved, (*di*, *tri*, *tetra*, *penta*, &c. *phyllum*, many-leaved, (*polyphyllum*), when it consists of two or more foliola, fig. 148.

9. Dentated, (*dentatum*), when it has at the margin short segments or indentations, but which are not deeper at most than the fourth part of the whole perianth. According to the number of these segments the perianth is, *bi*, *tri*, *quadri*, *quinque*, &c. or *multidentatum*, with two, three, four, five, or many segments.

10. Cleft, (*fissum*), when the perianthium is divided into laciniæ, but which reach only to the middle. It is often *bi*, *tri*, *quadri*, &c. *multifidum*.

11. Parted, (*partitum*), when the perianth is divided down to the base. These divisions are also named according to their number, as *bi*, *tri*, *quadri*, &c. *multipartitum*.

12. Labiated or bilabiated. (*labiatum* s. *bilabiatum*), when the perianth is deeply divided into two laciniæ,

both of which are dentated, as in garden sage, Salvia *officinalis*, fig. 73.

13. Intire, (*integrum*), when a monophyllous perianth is short, round at the base, and intire on the margin, fig. 118.

14. Urceolated, (*urceolatum*), when a monophyllous perianth is short, round at the base, and intire on the margin, fig. 118.

15. Shut, (*clausum*), when a polyphyllous or divided perianth applies itself closely to the corolla.

16. Tubular, (*tubulosum*), when a divided, cleft, or indented perianth, at its origin, is cylindrical and forms a tube.

17. Spreading, (*patens*), when in a monophyllous or polyphyllous perianth, the foliola or laciniæ stand quite open.

18. Reflected, (*reflexum*), when either the segments or laciniæ in monophyllous perianths, or the foliola in polyphyllous, are bent back.

19. Inflated, (*inflatum*), when the perianth is hollow, and bellies out.

20. Abbreviated, (*abbreviatum*), when the calyx is much shorter than the corolla.

21. Coloured, (*coloratum*), when the perianth is of another colour than green*.

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* In a monophyllous Perianth, the divisions are either called laciniæ, or segments (*dentes*), and these segments are distinguished by being obtuse (*obtusus*), acute (*acutus*), acuminated, (*acuminatus*), thorny (*spinosus*), &c. In the polyphyllous perianths, the particular pieces are called leafets (*foliola*), and they are described according to their form. As to the figure of the Calyx and its parts, see the definitions in § 6.

§ 69.

The GLUME, (*gluma*), is the peculiar calyx of the Grasses. It contains in general several flowers. The leaves of which it consists are called valves, (*valvulæ*). The kinds are as follows :

1. Univalve, (*univalvis*), that consists of only one valve, as in the ray grass, Lolium *perenne*.

2. Bivalve, (*bivalvis*), with two valves, as in most Grasses, fig. 96, 97, 102, 104.

3. Trivalve, (*trivalvis*), when there are three valves, as in Panicum *miliaceum*.

4. Multivalve, (*multivalvis*), that is composed of many valves.

5. Coloured, (*colorata*), that is of another colour than green*.

§ 70.

The COMMON PERIANTHIUM, (*anthodium*), is a calyx which contains a great number of flowers, in such a manner as that these flowers appear to form but one, as in dandelion, Leontodon *Taraxacum*, blue bottle, Centaurea *Cyanus*, sunflower, Helianthus *annuus*, &c. The kinds are,

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* The corolla of the Grasses, which is inclosed in the gluma, is also called gluma, because it hardly differs in appearance from the calyx, and, properly speaking, is but an interior calyx. In accurate description, the word calyx or corolla is prefixed to gluma. The gluma of the corolla is somewhat finer than that of the calyx, and the inner valve is membranaceous, but the outer green. This green valve is either without an arista (*mutica*), or awned (*aristata*). The awn, (*arista*), § 49, is only found on the corolla of Grasses, fig. 103.

1. One-leaved, (*monophyllum*), that consists but of one leaf, united at the base, but divided at top.

2. Many-leaved, (*polyphyllus*), that is compounded of several leaves,

3. Simple, (*simplex*), when the flowers are surrounded by a single row of leaves, fig. 221.

4. Equal, (*æquale*), when in a simple perianth the leaves are of equal length.

5. Scaly or imbricated, (*squamosum* s. *imbricatum*), when the common perianth consists of closely imbricated foliola, fig. 59, 76.

6. Squarrose, (*squarrosum*), when the foliola are bent back at the points.

7. Scariose, (*scariosum*), when the foliola are hard and dry: this is found in the Centaurea *glastifolia*.

8. Fringed, (*ciliatum*), when the margins of the foliola are beset with short bristles of equal length.

9. Muricated, (*muricatum*), when the margins of the foliola are set with short stiff prickles.

10. Thorny, (*spinosum*), when each leafet is provided with a thorn: there are either simple thorns, (*spinæ simplices*), or branched (*ramosæ*), fig. 152.

11. Turbinated, (*turbinatum*), when the perianth has quite the figure of a top, fig. 59.

12. Spherical, (*globosum*), when it has the form of a perfect sphere, fig. 152.

13. Hemispherical, (*hemisphæricum*), when it is round below and flat above, fig. 76.

14. Cylindrical, (*cylindricum*), when the perianth is round and long, as thick above as below.

15. Flat, (*planum*), when the foliola of the perianth are spread out quite flat.

16. Doubled or calyculated, (*auctum* s. *calyculatum*), when at the base of the common perianth there is another row of foliola that appear to form another calyx, as in dandelion, Leontodon *Taraxacum*, fig. 143, 270*.

The common perianth, (*anthodium*), is in general called by Linnæus the common calyx, (*Calyx communis*).

§ 71.

The foliola which cover the Catkin, § 64, serve in place of the calyx; and behind each stand the essential parts of the flower. These foliola are SCALES, (*squamæ*), fig. 37 †.

§ 72.

The PAPPUS, is a calyx consisting of hairs, or of a thin transparent membrane, observed only in particular flowers that are contained in a common perianth, (*anthodium*). The pappus remains constantly till the ripening of the seed, and we shall consider it more fully when treating of the seed, (§ 115). Fig. 84, 86, 87.

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* The leaves of the common perianth are called leafets, (*foliola* s. *squamae*), and in accurate description are denominated according to their outline.

† The foliola of the common perianth, of the catkin, of the strobilus and other parts, are called likewise *squamae;* but the connection always shows distincly of what we are speaking.

§ 73.

The Mosses have a peculiar calyx, differently formed from that of other plants, called PERICHAETIUM. The flowers of Mosses are so small that they cannot be seen without the help of a high magnifier. In general they are of different sexes, that is, some are intirely male, others female flowers. The calyx of the female flower remains till the fruit is ripe and appears at the base of the seta, (§ 21). The male flower is only visible with a high magnifier, and disappears after the fructification is completed.

In the male flowers the calyx consists of a number of leaves, which differ from the other leaves in being of a finer structure, and of another form. The calyx of the female flower is best seen when the fruit is ripe, when it is observed at the base of the seta, fig. 140. and consists of a number of imbricated leaves, which are distinguished from those of the Moss by their length or breadth. These leaves lie thick upon one another, and the whole is of a conical form.

§ 74.

The COROLLA is the envelope, or small leaves inclosed by the calyx, surrounding the interior parts of the flower, and of another colour than green. It consists either of one piece or of several; the first is called a monopetalous corolla, (*corolla monopetala*), the last polypetalous, (*corolla polypetala*). The pieces it consists of are called petals, (*petala*).

§ 75.

The MONOPETALOUS COROLLA is that which consists but of one piece, which, however, may be divided into segments, but which must always be intire at the base. The following are varieties of this corolla.

1. Tubular, (*tubulosa*), that consists of a single piece, hollow and of equal thickness. The small corolla or floret, which is found included in a common perianthium is also called tubular, although it sometimes departs from this form, fig. 60, 86, 275.

2. Club-shaped, (*clavata*), which forms a tube, growing gradually wider upwards, and narrower at the aperture, fig. 276.

3. Spherical, (*globosa*), which is narrow above and below, and wide in the middle, fig. 268.

4. Bell-shaped, (*campanulata*), that grows gradually wider to the mouth, so that it has nearly the appearance of a bell, fig. 62.

5. Cup-shaped, (*cyathiformis*), when a cylindrical tube grows gradually wider from below upwards, but the margin is upright and not bent back or contracted, fig. 273, 82.

6. Urceolated, (*urceolata*), when a short cylindrical tube extends itself into a wide surface, the margin of which is erect, fig. 274.

7. Funnel-shaped, (*infundibuliformis*), when the tube of the corolla grows gradually wide above, that is, obversely conical, but the rim pretty flat and turned out, fig. 269.

8. Salver-shaped, (*hypocrateriformis*), when the

tube of the corolla is perfectly cylindrical but very long, and the rim forms a broad expansion, fig. 267, as in Phlox.

9. Wheel-shaped, (*rotata*), when a cylindrical tube is very short, nearly shorter than the calyx, sometimes hardly perceptible, and its margin is quite flat. It is almost the same with the foregoing, only the tube is very short, as in shepherd's club, Verbascum.

10. Tongue-shaped, (*ligulata*), when the tube is not long, suddenly ceases, and ends in an oblong expansion, as in the Aristolochia *Clematitis*, fig. 271, and in some flowers that are contained in a common perianthium, fig. 84.

11. Difform, (*difformis*), when the tube gradually becomes wider above, and is divided into unequal lobes, as in some corollas that are included in a common perianthium, *e. g.* the bluebottle, Centaurea *Cyanus*.

12. Ringent, (*ringens*), when the margin of a tubular corolla is divided into two parts, of which the upper part is arched, the under oblong, and has some resemblance to the open mouth of an animal, as in sage, Salvia *officinalis*, fig. 72.

13. Masked, (*personata*), when both segments of the ringent flower are closely pressed together, as in snapdragon, Antirrhinum *majus*, fig. 49.

14. Bilabiate, (*bilabiata*), when the corolla has two segments or lips which lie over against each other, and which are themselves often laciniated or cleft, fig. 272.

15. One-lipped, (*unilabiata*), when in a ringent,

personate, &c. corolla, the upper or under lip is wanting, as in Teucrium, fig. 50 and 51.

§ 76.

The kinds of the MANY-PETALLED COROLLA, (*corolla polypetala*), are,

1. Rose-like, (*rosacea*), when petals, which are pretty round, and at their base have no unguis, form a corolla, fig. 150, 195.

2. Mallow-like, (*malvacea*), when five petals, which at the base are considerably attenuated, so unite below that they appear to be monopetalous, fig. 56.

3. Cross-like, (*cruciata*), when four petals which are very much produced at their base, stand opposite to one another, as in Sinapis *alba*, Brassica *oleracea*, *viridis*, *&c.* fig. 145.

4. Pink-like, (*caryophyllacea*), when five petals at their base are much elongated, and stand in a monophyllous calyx, as in Dianthus *Caryophyllus*, *&c.* fig. 110.

5. Lily-like, (*liliacea*), when there are several petals but no calyx. In some there are only three, in others they form a tube at the bottom. This makes the idea somewhat indefinite; but it ought to be remarked, that this kind of corolla never has a calyx, and that it is only proper to the lilies, (§ 123), fig. 66, 71, 146.

6. Two, three, four, five, &c. many petalled, (*di, tri, tetra, penta, &c. polypetala*), thus the corolla is denominated according to the number of the petals.

7. Papilionaceous, (*papilionacea*), when four petals differing in figure stand together; to these pe-

tals the following names have been given: (for instances examine the flowers of the common pea, Pisum *sativum*, or vetch, Vicia *sativa*, fig. 105, 30.)

a. The standard, (*vexillum*), is the uppermost petal, which is commonly the largest, and is somewhat concave, fig. 106.

b. The two wings, (*alæ*), are the two petals which stand under the vexillum, and opposite to each other on each side, fig. 107.

c. The keel, (*carina*), is the undermost petal; it is hollow, and stands under the vexillum, and opposite to it; and contains the germen, with the stamina and pistillum, fig. 108.

8. Orchideous, (*orchidea*), is a corolla composed of five petals, of which the undermost is long and sometimes cleft; the other four are arched and bent towards one another, fig. 33.

9. Irregular, (*irregularis*), consisting of four or more petals, which are of different lengths and inclination, so that they do not come under the description of the other kinds, fig. 134.

§ 77.

The particular parts of the corolla have besides appropriate names. The following are those of the MONOPETALOUS COROLLA:

1. The tube, (*tubus*), of a monopetalous corolla is the under part, which is hollow, and in general of equal thickness. All flowers of this kind of corolla have a tube, except the bell-shaped, and sometimes the wheel-shaped.

2. The border, (*limbus*), is the opening of the corolla,

la, especially when it is bent back, (§ 75, No. 1—11). The limbus is often dentated or deeply divided, and the divisions are called,

3. Segments or lobes, (*laciniæ* s. *lobi*), and they are denominated according to their figure, number, and situation.

4. The helmet, (*galea*), is the upper arched lacinia of a ringent or masked corolla, which is further denominated according to its situation, figure, and segments or laciniæ.

5. The gape, (*rictus*), is, in ringent flowers, the space between the two extremities of the helmet and the under lip.

6. The throat, (*faux*), in a monopetalous and ringent corolla, is the opening of the tube.

7. The palate, (*palatum*), in a personate corolla is the arch of the under lip which is so elevated as to close the faux.

8. The beard, (*barba* s. *labellum*), is the under lip of a ringent and personate corolla.

9. The lips, (*labia*), in the bilabiate and unilabiate flowers, are the two divisions, the one called the upper lip, (*labium superius*), and the other the under lip, (*labium inferius*). The galea and barba are likewise by some botanists called lips.

§ 78.

We have already said (§ 74), that the particular pieces of which the Corolla consists are called petals, (*petala*). In each petal the following parts are to be remarked.

1. The claw, (*unguis*), is the base of the petal, by which it is attached to the receptacle.

2. The expansion, (*lamina*), the upper part of the petal down to the unguis.

§ 79.

The corolla of the Mosses differs in external appearance from that of all other plants. It has this remarkable peculiarity, that after flowering it remains till the ripening of the fruit, but then appears under a quite different form. The female flower alone is furnished with a corolla. It consists of a pretty hard membrane that closely embraces the pistillum. It is fastened both above and below, and thus after flowering it must be detached and be designated by various names. The under part perfectly resembles the vagina on the straw of the Grasses, and is inclosed by the *perichætium* ; it is called a sheath, (*vaginula*). The upper part remains attached to the top of the fruit, and is called Calyptre, (*calyptra*).

This organ shall be more particularly mentioned in § 111.

§ 80.

Botanists call the collection of small florets which are contained in a common perianthium, a compound flower, (*flos compositus* s. *corolla communis*). Of these compound flowers there are the following kinds:

I. A semiflosculous flower, (*flos semiflosculosus*), when the general flower consists intirely of tongue-shaped florets, (*corollæ ligulatæ*), fig. 85, 270.

2. A discoid flower, (*flos discoideus*, s. *flosculosus*), consists intirely of tubular florets, (*corollæ tubulosæ*), as in thistles.

3. A radiate flower, (*flos radiatus*), has tubular florets in the middle, and tongue-shaped florets in the circumference, fig. 75. The middle, consisting of tubular florets, is called the disc (*discus*), and the circumference, containing tongue-shaped florets, is called the ray (*radius*).

4. A semiradiate flower, (*flos semiradiatus*), when there are tongue-shaped florets only on one side.

§ 81.

Another important part of the flower is the NECTARY, (*nectarium*). Linnæus comprehends in this all those bodies which have no resemblance to the other parts of the flower, in whatever variety of forms they may appear. These bodies, however, do not all secrete a sweet juice (*nectar*), and therefore do not all deserve the name of *Nectarium*. I shall in the mean time preserve this established name, and distinguish the various kinds by their functions. Nectaria may be divided into such as really secrete a sweet juice or honey, or serve for the preservation of it; or those which protect the true secretory organs or stamina, and also serve for promoting the impregnation.

§ 82.

Nectaria, which really secrete and exude honey, are glands (*glandulæ*), or nectariferous scales or pores, (*squamæ nectariferæ*, *pori nectariferi*). Of glands, there are the following varieties:

1. Sitting, (*sessilis*), which is not elevated on a foot-stalk, as in Sinapis, Brassica, &c. fig. 148.

2. Petiolated, (*petiolata*), which is furnished with a foot-stalk.

3. Spherical, (*globosa*).

4. Compressed, (*compressa*), which is flat on both sides.

5. Flat, (*plana*), that is scarcely convex, as in crown imperial, Fritillaria *imperialis*.

6. Oblong, (*oblonga*), that is besides of a long form.

7, Cup-shaped, (*cyathiformis*), that in form of a cup embraces the germen. When the seeds are ripe it changes into a hard, green body, as in the plants of the class Didynamia Gymnospermia, Asperifoliæ, &c. fig. 74*

The *squamæ nectariferæ* are small scales that exude honey, which is found in small holes, as in ranunculus. The small scales often secrete no honey, and are then called simply scales (*squamæ*).

The *Pori nectariferi* are small holes or pits exuding honey, and which are seen on different parts of the flower, as in Hyacinthus *orientalis*, &c.

§ 83.

Of the Nectaria, so called, which are destined for the reception of honey, there are the following kinds; *viz.* The hood, (*cucullus*); the cylinder, (*cylindrus*); the pit, (*fovea*); the fold, (*plica*); the spur, (*calcar*).

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* The glands are situated on every part of the flower, on the calyx, the corolla, the stamina and the pistillum. The glands alone secrete a honey juice.

The HOOD, (*cucullus*), is a hollow body like a bag or hood, that is quite separated from all the other parts of the flower, and has commonly a short footstalk, as in monkshood, *Aconitum*, fig. 135, 196. In some flowers there are such hood-like bodies, which contain no honey, as in Asclepias *Vincetoxicum*, fig. 89.

The cylinder, (*cylindrus*), is a part of the flower that has perfectly the shape of a cylinder, and therefore among most botanists goes by the name. It is constantly attached to the flower, as in African cranes-bill, Pelargonium, &c.

The PIT, (*fovea*), is a cavity for the reception of honey, situated either in the calyx, the corolla, or in some other part of the flower, as in Hyptis, &c.

The FOLD, (*plica*), is an oblong groove, formed by the bending inwards of the corolla, which sometimes happens.

The SPUR, (*calcar*), is a horn-shaped production of the corolla in which honey is found. Sometimes in the pointed part of the spur there is a gland which contains honey, but sometimes it is secreted in another part, and thence flows into the spur, as in the March violet, Viola *odorata*; Indian cress, Tropæolum majus, fig. 49, 112, 113.

§ 84.

All these parts of the flower may with propriety be called Nectaria; but some that are commonly called by the name are very different. Certainly those parts which serve for the protection of the nectarious juice, or of the pollen, or for the advancement of the fructification, deserve at least the name of reservoirs of honey. Such are the *Fornix*, the *Barba*, the *Filum*, and the *Corona*.

The ARCH, (*fornix*), is a small elongation of the corolla, which commonly covers the stamina, or is seated at the aperture of the corolla. Its form is very various, as in comfrey, Symphytum *officinale*, mouse-ear, Myosotis *scorpioides*, &c. fig. 81.

The BEARD, (*barba*), consists of a number of short hairs or soft bristles which are situated at the opening of the calyx or corolla; or on the petals, or at the bottom of the flower, as in Thymus, Iris, Periploca, &c. fig. 71, 90, 92, 114.

The THREAD, (*filum*), is a long, thick body of a tender substance, and found very numerous in the bottom of the flower. The kinds are,

1. Straight, (*rectum*) that has a quite straight direction, as in the passion-flower, Passiflora, fig. 27.

2. Horn-like, (*corniculatum*), that is short and crooked like a horn, as in Periploca, fig. 83, 91.

The CROWN, (*corona*), is a very variable body, which appears under many different forms, and in figure generally resembles the corolla. There are the following varieties:

1. One-leaved, (*monophylla*), as in the Narcissus, fig. 146.

2. *Bi*, *tri*, *tetra*, &c. *polyphylla*, consisting of two,

three, four or many leaves, as in Silene, Stapelia, &c. fig. 68, 98, 100, 110, 111, 153, 154.

3. Hood-like, (*cucullata*): this sort, an example of which may be found in Asclepias, covers the pistillum above, like a cap or hood, fig. 88.

4. Stamen-like, (*staminiformis*), which has the appearance of a stamen, as in Stratiotes.

N. Under these divisions all the Nectaria of Linnæus may be properly arranged and accurately determined. In some flowers, particularly the Asclepias, there appear small cartilaginous bodies, which are commonly called Tubercula, and seem to be imperfect or dried up glands.

The Nectaria of the Grasses appear very like the glume, but are distinguished by their extraordinary fineness. They are quite transparent, and very tender.

The plants which bear catkins, (*amenta*), have likewise Nectaria, which are generally called squamæ. They serve sometimes for the preservation of the honey, sometimes for other purposes.

§ 85.

In the flowers of Mosses there have hitherto been no traces of Nectaria discovered; we find, however, in these flowers transparent, articulated bodies, which have been called succulent filaments, (*fila succulenta*), and which perhaps answer the purposes of Nectaria, fig. 127, 130, 131, 133.

§ 86.

The STAMENS, (*stamina*), are one of the essential parts of the flower, and are long bodies which contain a quantity of dust or powder essential to the fructification.

The parts of the stamina are three, the filament, (*filamentum*), the anther, (*anthera*), and the powder, (*pollen*).

§ 87.

The FILAMENT, (*filamentum*), is a longish body that is destined for the support and elevation of the anther. In its figure it is very various.

1. Capillary, (*capillare*), that is all of equal thickness, and as fine as a hair.

2. Filiform, (*filiforme*), like the former, only thicker, fig. 68.

3. Awl-shaped, (*subulatum*), which is thicker below than above, fig. 67.

4. Dilated, (*dilatatum*), that is so compressed on the sides as to appear broad and leaf-like, fig. 69, 47.

5. Heart-shaped, (*cordatum*), the same with the foregoing, but with a margin above and pointed below, as in Mahernia, fig. 48.

6. Wedge-shaped, (*cuneiforme*), a dilated filament, that is pointed below but cleft above, as in Lotus *tetragonolobus*.

7. Loose, (*liberum*), that is not attached to any other filament.

8. Connate, (*connata*), when several grow together, forming a cylinder, as in the mallow, Malva, fig. 23, 27, 56.

9. Bifid, (*bifidum*), when a filament is divided into two parts.

10. Multifid or branched, (*multifidum* s. *ramosum*), when it is divided into many branches, as in Carolinea *princeps*, fig. 58.

11. Jointed, (*articulatum*), when the filament has a moveable joint, as in sage, Salvia *officinalis*.

12. Connivent, (*conniventia*), when several filaments bend towards one another at their points.

13. Incurved, (*incurvum*). that has a bend like a bow, fig. 45.

14. Declined, (*declinata*), when several filaments do not stand erect, but by degrees, without describing a large curve, bend towards the upper or under part of the flower, as in Pyrola.

15. Hairy, (*pilosum*), set with fine hairs.

16. Equal, (*æqualia*), that are all of equal length.

17. Unequal, (*inæqualia*), when some are long and some short, fig. 50, 51*.

§ 88.

The Anther, (*anthera*), is a hollow, cellular body, that contains a quantity of pollen. Its kinds are the following:

1. Oblong, (*oblonga*), which is long and pointed at both ends.

2. Linear, (*linearis*), that is long and flat, but all of equal breadth.

3. Spherical, (*globosa*).

4. Kidney-shaped, (*reniformis*), that is spherical on one side, but concave on the other, as in ground

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* The filaments are attached to different parts of the flower, which in accurate description must be specified.

ivy, Glechoma *hederacea*, fox-glove, Digitalis *purpurea*, &c. fig. 68.

5. Doubled, (*didyma*), when two seem to be joined together, fig. 45.

6. Arrow-shaped, (*sagittata*), that is long pointed and cleft at the base into two parts, fig. 67.

7. Bifid, (*bifida*), that is linear, but cleft above and below, as in the Grasses, fig. 94.

8. Peltated, (*peltata*), that is circular, flat on both sides, and attached by the middle to the filament, as in the yew, Taxus *baccata*, fig. 64.

9. Dentated, (*dentata*), that on the margin has dents or indentations, as in the yew, Taxus *baccata*, fig. 64.

10. Hairy, (*pilosa*), that is covered with hair, as in the dead nettle, Lamium *album*, fig. 65.

11. Awned, (*aristata*), that at the point runs out into two thin elongations, as in the arbutus Uva Ursi, fig. 63.

12. Crested, (*cristata*), when several cartilaginous points are set on the sides or on the base, as in some heaths, Ericæ.

13. Awnless, (*mutica*), when it has neither awn nor crest. It is the opposite of No. 11, 12.

14. Angulated, (*angulata*), that has several deep furrows, that form four or more angles.

15. Bilocular, (*bilocularis*), when the anther is divided by a partition into two parts or cells.

16. Unilocular, (*unilocularis*), when there is but one cell or cavity in the anther.

17. Bursting at the side, (*latere dehiscens*).

18. Bursting at the point, (*apice dehiscens*).

19. Free, (*libera*), that is not attached to another anther.

20. Connate, (*connatæ*), when several grow together, forming a tube, fig. 84, 86, 87.

21. Erect, (*erecta*), standing with its base straight on the point of the filament, fig. 67.

22. Incumbent, (*incumbens*), that is perpendicularly, or even obliquely attached to the filament. fig. 55, 126.

23. Lateral, (*lateralis*), that is attached by its side to the point of the filament, fig. 68.

24. Moveable, (*versatilis*), when Nos. 22 and 23 are so slightly attached to the filament that the least motion agitates the anther.

25. Adnate, (*adnata*), when the anther is closely attached to both sides of the point of the filament, fig. 69.

26. Sitting, (*sessilis*), that has no filament.

The internal structure of the anther is described particularly in the Physiology.

§ 89.

The POLLEN is a powder, that appears in the form of the finest dust. In the microscope its figure is various, being hollow and filled with a fertilizing moisture, of which more will be said in the Physiology.

§ 90.

In the genus of Orchis, (§ 143, No. 7.) and in some twining plants, as in Asclepias, Cynanchum,

Stapelia,

Stapelia, &c. the anther is without a cuticle, or rather it makes but a very large particle of the pollen.

The stamina of the Mosses are very like those of the genus Orchis. The filament is extremely short and articulated, the anthera itself is properly a single particle of pollen.

In the Equisetum the stamina are still more like the common. The rest of the Filices have stamina which resemble pollen. The same may be said of the Fungi.

§ 91.

The PISTIL, (*pistillum*), is the second essential part of the flower. It stands constantly in the middle, and consists of three parts, *viz.* the *Germen*, *Stylus* and *Stigma*.

§ 92.

The GERMEN is the undermost part of the pistillum, and is the rudiment of the future fruit. The number of germina is various; they are reckoned from six to eight, after which they are said to be several or many germina. The figure is also very various. In respect of situation, the germen is sometimes above, sometimes under; (for the meaning of which, see afterwards § 96). The principal kinds are,

1. Sitting, (*sessile*), that has no foot-stalk, fig. 46.
2. Pedicelled, (*pedicellatum*), furnished with a foot-stalk, fig. 27, 144.

§ 93.

The STYLE, (*stylus*), is seated upon the germen, and resembles a small column or stalk. The kinds of it are the following:

1. Hair-like, (*capillaris*), that is very slender, and of equal thickness.

2. Bristle-like, (*setaceus*), as slender as the former, but somewhat thicker at the base.

3. Thread-like, (*filiformis*), which is long and round.

4. Awl-shaped, (*subulatus*), thick below, above sparp-pointed.

5. Gross, (*crassus*), that is very thick and short.

6. Club-shaped, (*clavatus*), thicker above than below.

7. Two, three, four, &c. multifid, (*bi*, *tri*, *quadri*, &c. *multifidus*), cleft in a determinate manner.

8. Dichotomous, (*dichotomus*), divided into two parts, which are again divided at the points.

9. Terminal, (*terminalis*), which stands on the top of the germen.

10. Lateral, (*lateralis*), attached to the side of the germen.

11. Erect, (*rectus*), which stands straight up.

12. Declined, (*declinatus*), that inclines towards the side.

13. Abiding, (*persistens*), that does not fall off.

14. Withering, (*marcescens*), that withers and afterwards falls off.

15. Deciduous, (*deciduus*), that falls off immediately after impregnation.

The number of the styles must likewise be accurately counted, for there are often more than one style to one germen, and this must be particularly observed. The length of the style, whether longer or shorter than the stamina, is also to be mentioned.

§ 94.

The STIGMA means the top of the style. The kinds of it are as follows:

1. Pointed, (*acutum*), when it is a sharp point.
2. Blunt, (*obtusum*), when it forms a blunt point.
3. Oblong, (*oblongum*), when it is thick and elongated.
4. Club-shaped, (*clavatum*), resembling a small club.
5. Spherical, (*globosum*), forming a perfectly round globe.
6. Capitate, (*capitatum*), a hemisphere, the under side flat.
7. Emarginated, (*emarginatum*), when the last mentioned kind has a notch in it.
8. Peltated, (*peltatum*), that is formed like a shield.
9. Uncinated, (*uncinatum*), hooked at the point.
10. Angular, (*angulosum*), when it is furnished with close and deep furrows, which occasion projecting angles.
11. Three-lobed, (*trilobum*), which consists of three round bodies, somewhat pressed flat, fig. 153.
12. Dentated, (*dentatum*), when it is set with fine teeth.

13. Cruciform, (*cruciforme*), when it is divided into four parts, of which two are always opposite to each other.

14. Pencil-like, (*penicilliforme*), consisting of a number of short, thick, close, fleshy fibres, in form of a pencil.

15. Hollow, (*concavum*), when it is of a globular or longish form, but quite hollow, as in the violet.

16. Petal-like, (*petaloideum*), when it has the appearance of a petal, as in Iris, fig. 70.

17. Two, three, &c. multifid, fig. 84. (*bi*, *tri*, &c. *multifidum*).

18. Bent back, (*revolutum*), when the points of a bifid or multifid stigma are rolled back outwards, fig. 84.

19. Bent in, (*convolutum*), when the points of a divided stigma are rolled inwards.

20. Spiral, (*spirale*), when a multifid stigma is rolled up like the spring of a watch.

21. Plumose, (*plumosum*), when the stigma is set with fine hairs on both sides so as to have the appearance of a feather, as in the Grasses, fig. 94, 95.

22. Hairy, (*pubescens*), that is set with short white hairs.

23. Lateral, (*laterale*), which is situated on the side of the stylus or of the germen.

24. Sitting, (*sessile*), which when there is no stile rests on the germen.

The stigma, properly speaking, consists of a number of inhaling tubercles, which are not always visible without a magnifier. In the Mirabilis *Jalappa* they are to be seen distinctly.

§ 95.

The pistillum of Mosses is furnished with a germen, stylus, and stigma, like other plants. But in this tribe there are several pistilla, some only of which form perfect fruit, the others are barren. The equisetum has no style, neither have the other Filices and Fungi. In the Filices, the pistillum has the appearance of a small grain, so likewise that of the Fungi, only in this it is drawn together like a small net. In all these plants the parts can be observed only by means of a high magnifier.

§ 96.

With regard to the flower in general, it is to be remarked, that such flowers as have neither calyx nor corolla are called naked, (*nudi*); when the corolla is wanting, the flower is said to be apetalous, (*flos apetalus*), and when there is no calyx, a corollaceous or aphyllous flower, (*flos corallaceus* s. *aphyllus*). Flowers which have stamina and pistilla are called hermaphrodite, (*flores hermaphroditi*); when the pistilla are wanting, they are called male flowers, (*flores masculi*); and when there are no stamina, female flowers, (*flores fæminei*). In the description of the germen, (§ 92), we did not speak of its situation. In flowers it is situated either under the calyx, and the flower is then said to be above, (*flos superus* s. *epicarpius*), or the germen is then said to be below, *(germen inferum)*; or the germen is included in the calyx, and is then said to be above, *(germen superum)*; or in this case the flower is said to be below, *(flos inferus* s. *hypocarpius)*.

When in common we describe the situation of the germen we are to observe whether it is situated above or below the calyx, without attending to the place of the corolla; for the calyx is often under, and the corolla above. But in more accurate description we remark the situation of the corolla.

§ 97.

When plants have done flowering there proceeds from the germen (§ 92) the fruit, *(fructus.)* This is either naked seeds, (*semen*), or a skin, hard shell, or other substance containing the seeds, called pericarp, *(pericarpium)*, (§ 98). Thus all plants may be brought under two great divisions, namely, such as have naked seeds, (*vegetabilia gymnospermia*), that is to say, such where the germen changes into one or more naked seeds; and such as have their seeds covered, (*vegetabilia angiospermia*), or those whose germen changes into a pericarpium. Of the first kind, namely the naked seeded plants, there have yet been discovered only four varieties, *viz.*

1. One-seeded, (*vegetabilia monosperma*), where the single germen is one naked seed.

2. Two-seeded, (*disperma*), when out of two or one germen in a flower there proceed two naked seeds.

3. Four-seeded, (*tetrasperma*), when four germina or one four-partitioned germen in a flower change to four naked seeds.

4. Many-seeded, (*polysperma*), when out of several germina in one flower there proceed several naked seeds.

The parts of the pericarpium and the seed are subject to much variation, which we shall exemplify in the following paragraphs.

§ 98.

The PERICARPIUM is a cavity of various figure, containing seeds. The kinds of it are, *Utriculus*, *Samara*, *Folliculus*, *Capsula*, *Nux*, *Drupa*, *Bacca*, *Pomum*, *Pepo*, *Siliqua*, *Legumen*, *Lomentum*, and *Theca*.

§ 99.

The BLADDER, (*utriculus*), consists of a thin skin, which incloses a single seed. The kinds of it are these:

1. Loose, (*laxus*), that holds the seed inclosed quite loose, as in Adonis, Thalictrum, fig. 165, 166.

2. Strait, (*strictus*), that quite closely surrounds the seed, as in ladies bedstraw, Galium.

3. Cut round, (*circumscissus*), that bursts in the middle, and detaches itself, as in Amaranthus.

N. The Utriculus is distinguished from the exterior coat of the seed by this, that between the seed and the external coat there is a space, and that the seed is connected with it by the umbilical chord. The utriculus differs from the nut in being less hard and more yielding.

§ 100.

§ 100.

The WINGED-FRUIT, (*samara*), is a pericarpium, which contains one or at most two seeds, and is surrounded by a thin, transparent membrane, either in its whole circumference, or at the point, or even on the side. Examples of this are seen in the fruit of the elm, *ulmus*, fig. 162, 163; mapple, *acer;* ash, *fraxinus;* birch, *betula;* and many others. The kinds of it are determined by the number of the seeds, whether there be one or two in the fruit, or according to the place to which the thin membrane is attached, which is called the wing, (*ala*).

§ 101.

The FOLLICLE, (*folliculus*), is an oblong pericarpium, which bursts longitudinally on one side, and is filled with seeds. The follicle is seldom single, there are generally two together. Its varieties are determined according to the attachment of the seed; when, for example, there is a partition in the middle to which the seed is fixed; or when it is attached to both sutures at which this fruit bursts; as in Asclepias *syriaca*, Vinca, Oleander, &c. fig. 170.

§ 102.

The CAPSULE, (*capsula*), is a pericarpium, consisting of a thin coat which contains many seeds, often divided into cells, and assuming various forms. The parts of the capsule are the following:

a. The partition, (*disscpimentum*), is a firm membrane that intersects and divides the inner cavity of the capsule.

b. The cells, (*loculàmenta*), are the spaces between the partitions.

c. The *columella* is a filiform body that passes through the middle of the Capsule, and to which the partitions are attached, fig. 169.

d. The valves, (*valvulæ*), form the outward coat of the Capsule, which bursts longitudinally in several parts.

e. The suture, (*sutura*), is a deep furrow which appears on the outside of the coat.

The different sorts of capsules are distinguished according as they are round, long, &c. and further, according as they are,

1. Unilocular, (*unilocularis*), when there are no divisions.

2. Two, three, four, &c. or many celled, *bi*, *tri*, *quadri*, or *multilocularis*, according to the number of the cells, fig. 155.

3. Two, three, &c. or many-valved, *bi*, *tri*, &c, *multivalvis*, according to the number of the valves that appear on the bursting of the capsule, fig. 156, 169

4. Two, three, &c. many-seeded, (*bi*, *tri*, &c. *polysperma*), according to the number of the seeds.

5. Tricoccous, (*tricocca*), when a trilocular capsule appears as if three were grown together, as in the tea-shrub, Thea *viridis*, Euphorbia, &c.

6. Berried, (*baccata*), when the coat is fleshy and soft.

7. Corticated, (*corticata*), when the external coat is hard, and the internal soft; or when the external is spongy, and the inner membranaceous, as in Magnolia, Illicium *anisatum*.

Woody, (*lignosa*), when the coat is very hard, but still bursts in valves.

The Capsule has different names according to the various ways in which it opens, *e. g.* bursting at the top, (*apice dehiscens*); bursting at the base, (*basi dehiscens*), bursting in the middle, (*circumscissa*), opening with a lid, *operculata*, &c.

The fruit of the Hepatic Mosses, (*Musci hepatici*), is likewise called a Capsule. They have over the Capsule a thin, light, deciduous membrane called calyptre, (*calyptra*). The Capsule bursts in four or two valves, (*quadri*-vel *bivalvis*), fig. 227. The four or more valve-like bodies are called threads, (*fila*). At the seeds are other threads formed like a small chain, which are called *catenulæ*. In the bivalved capsules there is a slender column on which the seeds hang, which is called *columnula* s. *sporangidium*.

The Filices have one or more capsules, in general kidney-shaped, which form on some an elevated articulated border. This border is called *fimbria*.

§ 103.

The NUT, (*nux*), is a seed covered with a hard shell, which does not burst; as the hazle-nut, Corylus *avellana*, the oak, Quercus *robur*, the hemp, Cannabis *sativa*, fig. 205. The shell is called *Putamen*, and is described according as it is hard (*durum*), or brittle *(fragile)*. The seed contained in the nut is called the kernel (*nucleus*). We remark likewise whether the nut is two or three-sided, (*bi*, vel *trisperma*), or whether it is divided into cells, namely, two, three, or many-celled, (*bi*, *tri*, vel *multilocularis*).

§ 104.

The DRUPE, (*drupa*), is a nut which is covered with a thick, fleshy, succulent or cartilaginous coat. The following are its varieties:

1. Berried, (*baccata*), when it is surrounded by a very succulent coat; as in the cherry, Prunus *cerasus;* the plumb, Prunus *domestica;* Peach, Amygdalus *Persica;* Apricot, Prunus *Armeniaca*, &c.

2. Fibrous, (*fibrosa*), when instead of a fleshy it has a fibrous coat, as in the cocoa-nut, Cocos *nucifera*.

3. Dry, (*exsucca*), when instead of a fleshy coat, it is covered with a spongy, membranaceous or coriaceous substance, as in the walnut, Juglans *regia;* almond, Amygdalus *communis*; Tetragonia *expansa*, Sparganium.

4. Winged, (*alata*), when the Drupa has a membranaceous rim, which is called a wing, as in Halesia.

5. Bursting, (*dehiscens*), when the external rind bursts. Properly speaking this is not peculiar to the Drupa, but it is the case with many species, as in walnut, Juglans *regia;* nutmeg, Myristica *moschata*, fig. 204, 206, 209, 211.

6. One, two, three, four nutted, &c. (*mono*, *bi*, *tri*, *tetrapyrena*), which contains one, two, three or four nuts. But if the hard shell of the nut grows to the kernel, it is called a pyrenous berry.

In accurate description we must attend to the figure of the nut, as well as to its cells. The nut of the Drupa has sometimes two, three, or more cells, fig. 171, 172, 173.

§ 105.

The BERRY, (*bacca*), is a succulent fruit which contains several seeds, and never bursts. It incloses the seeds without any determinate order; or it is divided by a thin membrane into cells. There are the following kinds:

1. Succulent, (*succosa*), which consists of a very soft, succulent substance, as in the gooseberry, Ribes *grossularia*, &c.

2. Corticated, (*corticosa*), which is covered with a hard rind, so that it cannot be bruised. It might be taken for a capsule, but it never bursts, and is filled with a juicy substance in which the seeds lie, as in Garcinia *Mangostana*.

3. Dry, (*exsucca*), that instead of a fleshy substance, is covered with a coriaceous or coloured skin, as in the ivy, Hedera *helix*.

4. One, two, three, many-seeded, (*mono*, *bi*, *tri*, *polysperma*), according to the number of seeds which the berry contains.

5. One, two, three, many-celled, (*uni*, *bi*, *tri*, *multilocularis*), according to the number of cells into which the berry is divided.

6. Two, three, &c. pyrenous, (*di*, *tripyrena*, &c.) when the particular seeds have a hard shell like the nut, but with this difference, that the hard rind is inseparably attached to the skin of the seed, as we have already said, § 104, No. 6. In the species of apple this is sometimes the case*.

§ 106.

The APPLE, (*pomum*), is a fleshy fruit, that internally contains a capsule for the seed. It differs from the celled berry, in having a perfect capsule in the heart. It is considered according to its substance and figure, whether it is fleshy or coriaceous, round, long, &c. Examples of this sort of pericarpium we have in the common apple, Pyrus *malus*, pear, Pyrus *communis*, quince, Pyrus *cydonia*, &c.

§ 107.

The PUMPKIN, (*pepo*), is commonly a succulent fruit, which has its seeds attached to the inner surface of the rind, as in the gourd, Cucurbita *pepo*; cucumber, Cucumis *sativus*; melon, Cucumis *melo*; passion-flower, Passiflora; water-soldier, Stratiotes *aloides*, &c. The sorts of Pepo are,

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[*] Of the Berry it is further to be remarked, that if in one flower there are many styles, and each of the germina bears a berry, all the small berries (*acini*) grow into one, and are called a compound berry (*bacca composita*), as in the rasp, Rubus *idæus*, *&c.*

This is likewise the case in the Drupa, *e*, *g*. the breadfruit, Artocarpus.

In descriptions the figure of the berry is carefully attended to.

1. One, two, three, &c. many-locular, (*uni*, *bi*, *tri*, *&c. multilocularis*), according to the number of the cells, fig. 210, 212.

2. Half-locular, (*semilocularis*), when the partition does not reach to the centre.

3. Fleshy, (*carnosa*), that is full of a firm, fleshy substance.

4. Juicy, (*succosa*), that is filled with a very soft substance.

5. Dry, (*exsucca*), that contains neither fleshy nor soft substance.

6. Cortical, (*corticosa*), which has a very firm, hard rind.

The external figure of the Pepo is not very various, and is, in general, either round, club-shaped, oblong, &c.

§ 108.

The SILIQUE, (*siliqua*), is a dry, elongated pericarp, which consists of two halves or valves, and externally, where these are connected, forms an upper and under suture. Internally the seeds are attached to the margin of the partition on both sides of the suture, the upper as well as the under, *e. g.* in the mustard, Sinapis *alba*, cabbage, Brassica *oleracea*, *&c.* fig. 190, 191. When the Siliqua is as broad as it is long, it is called silicle (*silicula*), fig. 187, 188, as in the garden cress, Lepidium *sativum*; shepherd's purse, Thlaspi *bursa pastoris*. The Siliqua is distinguished according to the situation of the partition, (*dissepimentum*). When both valves of this pericarpium are flat, and the partition, which reaches from one suture to the other, is of equal breadth, we say the valves run parallel with the partition, (*valvulis dissepimento parallelis*). But if both valves are swelled and hollow, so that the two sutures stand in the centre of the pericarp, and the partition is much narrower than the greatest breadth of the fruit, we say, the valves run contrary to the partition, (*valvulis dissepimento contrariis*). Many varieties take place in the figure of the Siliqua*.

§ 109.

The LEGUME, (*legumen*), is a dry, elongated pericarp, that consists of two halves or valves, externally forming two sutures. The seeds are attached to both margins of the under suture only. The kinds of the legumen are,

1. Membranaceous, (*membranaceum*), when both valves consist of a transparent membrane.

2. Coriaceous, (*coriaceum*), when the two valves are of a thicker and tougher substance.

3. Fleshy, (*carnosum*), when the two valves consist of a soft fleshy substance.

4. Woody, (*lignosum*), when both valves are as hard as a nut-shell, and do not burst.

5. Mealy, (*farinosum*), when the seed is surrounded with a mealy substance, as in Hymenæa *curbaril*.

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* Of the Siliculæ, there are some which have a double shell, the exterior softer and spongy, the interior harder, which contains the seed, inclosed in cells. These are called drupaceous Silicles, (*siliculæ drupaceæ*). But the kinds of silicle which never burst, are called *baccatæ*. Of the first kind, Bunias, and of the second, Crambe, afford examples.

6. Torolose, (*torolosum*), when both valves are round and thick, fig. 174, 175.

7. Ventricose, (*ventricosum*), when the valves internally are distended with air.

8. Compressed, (*compressum*), when the valves are both flat.

9. Channelled, (*canaliculatum*), when the upper suture is deeply furrowed, as in Lathyrus *sativus*.

10. One, two, or many-seeded, (*mono*, *di*, vel *polyspermum*), according to the number of the seeds.

11. Spiral, (*cochleatum*), when it is twisted like the shell of a snail, as in Medicago *.

§ 110.

The LOMENT, (*lomentum*), is an elongated pericarpium, consisting of two valves; externally it forms sutures, but, like the legume, it never bursts. Internally it is divided into cells by small transverse partitions, which contain only one seed attached to the under suture. It never bursts longitudinally, like the two former pericarps; but when it opens, the partitions detach themselves in small pieces. The kinds of this pericarp are the following:

1. Cortical, (*corticosum*), when the outer shell is very hard and woody, but the internal cavities are filled with a soft substance, as in Cassia Fistula, fig. 192, 194.

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* There are still other kinds, which are named according to their figure, and according as the surface is set with hairs, bristles, wings, points, or prickles.

2. Articulated, (*articulatum*), when the transverse partitions appear distinctly on the outside, and are easily divided into joints, as in Hedysarum.

3. Intercepted with isthmuses, (*isthmis interceptum*), when the transverse partitions are easily seen, and also easily separate, but the cells are much smaller than the articulations, as in Hippocrepis.

§ 111.

The CASE, (*theca*), is the fruit of the frondose Musci. It is a dry fruit that opens in the middle with a lid, and is furnished with particular parts.

A. The Calyptre, (*calyptra*), is a tender skin that like a cup loosely covers the top of the theca, (§ 79). It is,

1. Intire, (*integra*), that wholly covers the top of the theca, as in Grimmia *extinctoria*.

2. Half, (*dimidiata*), that only half covers the top of the theca, as in most Musci, fig 138.

3. Hairy, (*villosa*), that is composed of hairs, as in Polytrichum, fig. 136.

4. Dentated, (*dentata*), when the rim is set with teeth, as in Grimmia *dentata*.

B. The Lid, (*operculum*), is a round body that closes the opening of the theca, and when the seed is ripe falls off. It is,

1. Convex, (*convexum*), that has a raised or arched surface.

2. Conical, (*conicum*), that is wide below, but runs above into a round point.

3. Acute, (*acutum*), that is wide below, but above grows gradually into an acute point, fig. 138.

4. Acuminated, (*acuminatum*), when the upper part is drawn out into a very long point, fig. 137.

5 Flat, (*planum*), when the operculum is quite flat.

6. Mucronate, (*mucronatum*), when the operculum is quite flat, but on the upper side, in the centre, has a bristle-like point.

C. The Fringe, (*fimbria* s. *annulus*), is a narrow sinuated membrane, that is set with small membranaceous teeth, and lies within the operculum. This body possesses great elasticity, and thus serves to throw off the operculum from the theca, fig. 261.

D. The Mouth, (*peristoma* s. *peristomium*), is the membranaceous rim which surrounds the mouth of the theca. The peristoma is of two kinds:

1. Naked, (*nudum*), that is intire without either teeth or eminences, fig. 178.

2. Figured, (*figuratum*), set with membranaceous teeth.

a. With one row, (*ordine simplici dentatum*), when there is a single row of teeth round the opening. These are distinguished according to their number and situation, &c. as,

α. Four, sixteen, or thirty-two dentated, (*quadri, sedecim*, vel 32 *dentatum*). No other differences in the teeth have been yet observed, fig. 176, 177, 179, 180.

β. With divided teeth, (*dentes bifidi*), when the points of the teeth are divided.

γ. Twisted, (*contorti*), when the teeth are

drawn

drawn together, and twisted into the form of a cylinder, fig. 184.

b. With a double row, (*ordine duplici dentatum*), when behind one row of teeth there is a second, fig. 181.

α. Not cohering, (*non cohærentes*), when the teeth of the inner row do not cohere, but stand free.

β. Cohering at the points, (*apice cohærentes*). When the teeth of the inner row cohere at their points.

γ. Ciliato-dentate, (*ciliato-dentatum*), when the inner row has alternately teeth and bristles.

δ. Membranaceo-dentate, (*membranaceo-dentatum*), when the teeth of the inner row cohere below by means of a membrane.

E. The Epiphragm, (*epiphragma*), is a thin membrane, which stretches over the mouth of the theca; it is found only in the genus Polytrichum, fig. 176.

F. The Seed-column, (*sporangidium* s. *columnula*), is a slender, thread-like body, that passes through the middle of the theca, and to which the seed is attached. It is analogous to that body which in a capsule is called by the same name.

G. The *Apophysis* is a fleshy, round, or oblong body, that appears at the base of the theca. Sometimes it is very small, and almost imperceptible; sometimes, however, larger than the theca itself, fig. 176. 179.

In one genus of Musci (the Phascum), the operculum never separates from the theca: but as soon as the seed is ripe, the whole theca falls off. As no mouth can be seen in this Moss, it is said to be without one *(peristoma nullum)*.

§ 112.

In the Fungi the capsules are hidden in the substance of the gills, pores, prickles or papillæ, or where these are wanting, in the fleshy substance. The capsules open at the top and disperse the seeds in very slender fibres. In the genus Octospora, there are eight seeds in a capsule, fig. 286, 287. In some species of the same genus the seeds are included by twos in one membrane, and there are eight of these double seeds in one capsule, fig. 283, 284. Different genera of Fungi, and among others the Lycoperdon, have numerous seeds, which compose their whole inner substance, fig. 7. Others, as the genus Peziza, have loose capsules.

§ 113.

According to the explanation given in § 97, the fruit is that part which is formed from the germen, whether it change into naked seeds or into a pericarpium. The botanist can never form a proper judgment of any fruit till he is acquainted with the mode of its production. The calyx, the corolla, the nectarium, the receptacle, may after flowering envelope the germen, may grow with it, and thus form a particular sort of fruit that may have the appearance of a pericarpium without being one. Such a production is called a false fruit, (*fructus spurius*). Some of these, on account of their resemblance, have got the name of that sort of pericarp which, without accurate investigation, they most nearly resemble. Others have got peculiar names; for instance,

1. Strobile, (*strobilus*), is a catkin, (§ 64), the scales of which have become woody, and, according to the nature of the plants, contain one or two loose seeds, or even nuts, under each scale. The whole has the appearance of a particular sort of fruit. The kinds of the strobilus are,

α. Cylindrical, (*cylindricus*), fig. 193.
β. Conical, (*conicus*),
γ. Ovate, (*ovatus*)
δ. Spherical, (*globosus*), &c.

2. The target, (*pelta*); this is seen in the Lichens, and is a longish, blunt, flat, leaf-like receptacle, in the substance of which the seeds lie hid, fig. 226.

3. The shield, (*scutella*), is likewise found in the Lichens, and is a plate-shaped, flat, sometimes convex and sometimes concave receptacle, furnished with a margin; sometimes raised and sometimes depressed, which incloses the seeds in its substance, fig. 3.

4. The tubercle, (*tuberculum*), is also found in Lichens, and is a convex receptacle, of a figure somewhat various, in the substance of which the seeds lie.

The other sorts of false fruit are, as we have already said, denominated according to their resemblance, as,

α. The false capsule, (*capsula spuria*). The Beech, Fagus *sylvatica* bears such. The proper fruit of this tree are two three-cornered nuts that stand close together, and are encompassed by a coricaceous prickly calyx, which has the appearance of an unilocular, four-valved capsule. The dock, Rumex, bears but a single seed, which the abiding calyx surrounds like a capsule. The Carex bears one seed, which is inclosed by the nectarium, and thus acquires a capsule-like form.

b. The false nut, (*nux spuria*). The Trapa *natans*, has a single seed which is attached to the calyx, the foliola of which change into a hard nut-shell with four spines. The Coix, *lachryma Jobi*, has a single seed, inclosed however by the calyx and corolla, and becomes hard and shining like a stone. The Mirabilis *jalapa*, retains the under part of the tube of the corolla, which grows with the seed, and forms a nut.

c. The false drupa, (*drupa spuria*). The yew, Taxus *baccata*, bears a nut that is half sunk in the fleshy receptacle, and thus appears like a drupa. This is the case likewise with the Anacardium and Semicarpus, (§ 117.)

d. The false berry, (*bacca spuria*). The juniper, Juniperus *communis* has a catkin, (§ 64), and must regularly bear a strobilus; but the scales grow together, become fleshy, and assume the appearance of a berry. The strawberry, Fragaria *vesca*, bears detached seeds upon a fleshy receptacle, and looks like a berry, (§ 117). The Basella incloses its seeds in the calyx and corolla, which become fleshy, and thus has the appearance of a perfect berry.

More examples of this kind may be learned by attentive observation.

With regard to the Strobilus it remains to be noticed, that we often falsely so call the scaly imbricated seeds of the tulip-tree, Liriodendron *tulipifera*, and the imbricated capsules of the Magnolia, fig. 159. But the Strobilus proceeds only from a catkin.

The capsules or membranes which inclose the seeds of Lichens in shields, scutellæ or tubercles, are found in these parts in a vertical position; they open only at the top, and scatter the seeds in the form of a fine powder. They are only to be seen when one takes a thin section of these parts and uses the assistance of a microscope.

§ 114.

The SEED, (*semen*), is that part of the plant which is destined to its propagation. It consists of two halves, which change at germination into leaves, and are called seed-leaves or cotyledons, (*cotyledones*). Between these, on one side, lies the corcle, (*corculum*), which consists of two bodies, one sharp-pointed, which descends into the earth, and becomes a root, rostel, (*rostellum*); the other ascending, and afterwards to form the stem and leaves, called plumule,

mule, (*plumula*). The seed besides is covered with a double integument, the outer one being thick and of a firm consistence, the inner transparent and tender. The external one is called the external tunic, (*tunica externa*), the inner, the internal membrane, (*membrana interna*). The place in the seed which is occupied by the corculum may be seen externally, as it is marked by a deep impression called the eye, or external scar, (*hilum*). The seed, till it has attained its full ripeness, is fastened by a small thread called the umbilical cord, (*funiculus umbilicalis*).

Plants have been divided according to the various ways in which the seed germinates; *viz.* such as have no seed-leaves are called acotyledonous, (*acotyledones*); such as have one, two, or more seed-leaves, are called monocotyledonous, &c. (*mono*, *di*, *polycotyledones*). But an accurate observation of nature shews the above division to be inept. In what different ways seeds germinate will be shewn in the Physiology, § 245.

The forms of the seed are very various, but they are easily distinguished. By means of the umbilical cord, seeds are attached, in the pericarpium, either to the rim, to the receptacle, to the inner surface, to the valves, &c.; but when they are found so close in a berry that their attachment cannot easily be seen, they are said to be nidulant seeds, (*semina nidulantia*). The substance of seeds is firm, and we have but few examples of soft seeds. Linnæus sometimes speaks of two-celled seeds, (*semina bilocularia*); but such can no more occur in nature

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than eggs with two cells; what Linnæus thus calls, are generally two-celled nuts*.

§ 115.

To the seed and to the pericarp belong yet other organs, which contribute to the accurate knowledge of plants, *viz.*

1. The ARILLUS is a soft membrane extended over the seed; it is called,

  a. Succulent, (*succulentus*, *baccatus*, s. *carnosus*), when it is thick and fleshy, as in the spindle-tree, Euonymus *europæus*.
  b. Cartilaginous, (*cartilagineus*), when it is of a firm consistence, and thick.
  c. Membranaceous, (*membranaceus*), when it consists of a thin, transparent tunicle.
  d. Halved, (*dimidiatus*), when only the half of the seed has a covering.
  e. Torn, (*lacerus*), when the arillus is irregularly laciniated, fig. 206.
  f, Caped, (*calyptratus*), when it covers the top of the seed, as the calyptra surrounds the top of the theca in Mosses, (§ 111.)
  g. Net-like, (*reticulatus*), when it closely embraces the seed like a fine web. Examples

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* In the animal kingdom there has indeed been discovered a leech, (*hirudo octoculato*), which produces one egg, and from this proceed eight, ten, or more young. But it may be questioned whether this is really a single egg, or whether it is not several connected together by some mucilaginous matter. In plants there is no instance of this known to me.

of this are found in the species of Orchis, and particularly in all very small seeds. In these plants the seeds are inclosed as in a bag*.

2. The PAPPUS is the calyx of each particular floret inclosed in a common perianth, (§ 70). During the time of flowering, the pappus is in most plants so very small that its distinguishing characters cannot well be observed, when the seed ripens it attains its perfection, and then exhibits the following varieties:

- *a.* Sitting, (*sessilis*), when the pappus sits on the top of the seed, without any foot-stalk, fig. 189.
- *b.* Stipitate, (*stipitatus*), when it is supported on a pedicle, fig. 185, 186.
- *c.* Abiding, (*persistens*), when it is so closely attached to the seed that it does not fall off.
- *d.* Caducous, (*caducus* s. *fugax*), when it falls off upon the ripening of the seed.
- *e.* Calycled, (*calyculatus* s. *marginatus*), when a membranaceous rim rises over the seed: this is either,
  - *α.* Whole, (*integer*), when the rim is not indented, and surrounds the top of the seed, as in Tanacetum, Dipsacus; or,
  - *β.* Halved, (*dimidiatus*), when the rim sur-

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* The Arillus does not surround the seeds alone; sometimes it even incloses the pericarpium, as in the nutmeg, Myristica *moschata;* what is called mace is an arillus which surrounds the fruit, fig. 206.

rounds only the half of the top of the seed.

f. Chaffy, (*paleaceus*), when small leaves like scales stand round the top of the seed, as in the sun-flower, Helianthus *annuus*, and many others. This chaffy pappus consists of two, three, five or more leaves, (*di*, *tri*, *penta*, vel *polyphyllus*); the foliola are lanceolate, obtuse or setaceous.

g. Awned, (*aristatus*), when one, two, or even three, but never more, straight setæ stand round the top of the seed, as in Bidens *tripartita*.

h. Stellate, (*stellatus*), when five long pointed bristles are spread like a star on the top of the seed.

i. Hair-like, (*capillaris* s. *pilosus*), when many very fine, and commonly shining, white, simple hairs stand on the crown of the seed, fig. 186.

k. Setaceous, (*setaceus*), when many rigid bristles, that are of another colour than white, and all of them quite smooth, surround the top of the seed, fig. 189.

l. Fringed, (*ciliatus*), when stiff, close-pressed setæ, are set with very short, and hardly visible hairs. This kind connects the former with the following species.

m. Plumose, (*plumosus*), when the pappus is composed of fine hairs or setæ, that are themselves set with fine hairs on the sides, fig. 185.

n. Uniform, (*uniformis*), when all the pappi in a common perianth are of the same form.

o. Unlike, (*difformis* s. *dissimilis*), when in a common perianth the pappi are of different forms.

p. Doubled, (*geminatus*), when a pappus is composed of two kinds; for instance, when the pappus on the outside is calyciform, on the inside capillary or hairy; or on the outside calyciform, on the inside setaceous; or also on the outside calyciform, and on the inside plumose.

N. We must beware of confounding the hairs which sometimes cover seeds with the true pappus. In Eriophorum there is no true pappus, but merely hairs that surround the seeds: this is called *Lana pappiformis.*

3. The TUFT, (*coma*), is a body that appears like a pilose pappus, and is not to be distinguished from it except by its origin. The coma is always attached to the seeds that are contained in a pericarp, and never occupies the place of a calyx, as in Asclepias *syriaca*, Epilobium, &c. fig. 168, 169.

4. The TAIL, (*cauda*), is a long, thread-like body, that appears on the top of the seed, or of the utriculus, and is set with fine hairs, as in the pasque-flower, Anemone *Pulsatilla*, Clematis, and many others, fig. 164.

N. The seeds of the Typha latifolia seem to have a pappus; but it is at the top a smooth straight cauda, and the seed is supported on a long stalk, that is set with hairs on the under part, like a pappus.

5. The ROSTRUM is a persistent style remaining on the seed, or on the pericarp, as in Scandix, Sinapis, &c. When the rostrum is crooked, it is called a horn, (*cornu*), as in the capsule of Nigella *damascena*, and many others.

6. The WING, (*ala*), is a cartilaginous, thin, transparent membrane, that is found on the top, on the back, or on the margin of the seed or of the pericarp. Of this there are the following varieties :

a. *Monopterygia*, when there is but one wing.
b. *Dipterygia*, s. *bialata*, when there are two wings, fig. 161.
c. *Tripterygia*, s. *trialata*, three wings.
d. *Tetraptera*, s. *quadrialata*, four wings.
e. *Pentaptera* et *polyptera*, s. *quinquealata* et *multialata*, with five or many wings. This kind is found in many capsules, and in the seeds of some umbelliferous plants. The seeds likewise of umbelliferous plants that have many wings are called *semina molendinacea*.

N. To this term is also to be referred the membranaceous transparent margin, (*margo membranaceus*), which surrounds some pericarps and seeds.

7. The Crest, (*crista*), is a thick, coriaceous or cork-like wing, indented or deeply split, that appears on the top of some pericarps, as in Hedysarum *Crista Galli*.

8. The RIBS, (*costa* s. *jugum*), are very prominent ridges, that are seen in some pericarps, and on the seeds of umbelliferous plants.

9. The Wart, (*verruca*), is a small, obtuse, round eminence, found on many seeds.

10. HOARINESS, (*pruina*), is a fine white powder, that often covers the seeds and the pericarp, as in the plumb, Prunus *domestica*, *&c.*

N. With regard to the surfaces and cloathing which are proper to the pericarp and the seeds, we refer to § 6 and 48, fig. 157, 158, 160, 161.

§ 116.

The RECEPTACLE, (*receptaculum*, *thalamus*, *basis*), is the place on which the germen or the ripe fruit stands. It is of two kinds, *viz.* proper, (*proprium*), bearing but one flower, or common, (*commune*), bearing several flowers, as is the case in the compound flowers; § 80.

§ 117.

The simple receptacle, (*receptaculum proprium*), is not much raised: it has commonly no greater surface than is necessary for the space occupied by the flower-stalk. Several plants, however, are an exception to this, particularly those that have many styles. In these it cannot be otherwise; a number of styles occupies a considerable space; and therefore the receptacle is sometimes flat, (*planum*), sometimes arched, (*convexum*), and sometimes spherical, (*globosum*). But the most remarkable kinds are the dry, (*siccum*), that is of a hard substance, and the fleshy, (*carnosum*), that is soft and succulent, as in the strawberry, Fragaria *vesca*, fig. 213. This fruit is not a proper berry, but is a fleshy receptacle with free seeds. In a few plants that have but one style, the receptacle is uncommonly strong and fleshy, as in the cashew nut, Anacardium *occidental e*, fig. 214. The fruit of this plant is a nut, that stands on a pear-shaped fleshy receptacle, as is the case likewise with the Semicarpus *Anacardium*, fig. 216 and Gomphia *japotapita*, fig. 215. But the most remarkable is a Japanese tree that bears small capsules, and the flower-stalk of which is so extremely thick and fleshy, that it has the appearance of a fleshy receptacle: it is the Hovenia *dulcis*, fig. 208.

Another kind of receptacle still is seen in unilocular capsules: it is found in the centre of these, is pyramidal, and of a coriaceous substance: this is called a spongy receptacle, (*receptaculum spongiosum*).

§ 118.

The common receptacle, (*receptaculum commune*), is of wide circumference, and contains a multitude of flowers. It is of the following kinds:

1. Flat, (*planum*), that is perfectly even, fig. 218.
2. Convex, (*convexum*), that is somewhat elevated in the centre.
3. Conical, (*conicum*), that rises in the centre into a high round point, fig. 221.
4. Smooth, (*glabrum*), that is destitute of hairs or points.
5. Hairy, (*pilosum*), that is set with stiff, short hairs.
6. Villous, (*villosum*), that is set with long, soft hairs.

7. Setaceous, (*setaceus*), that is covered with stiff, bristle-like hairs.

8. Prickly, (*apiculatum*), when it is covered with fleshy, erect, short points.

9. Warty, (*tuberculatum*), when it is covered with small round eminences.

10. Punctured, (*punctatum*), when the surface is covered with small, deep holes, fig. 218.

11. Scrobiculate, (*scrobiculatum*), when there are deep round pits on the surface, fig. 221.

12. Honey-combed, (*favosum*), when large deep holes, like the cells in honey-combs, cover the surface.

13. Various, (*varium*), when the common receptacle is smooth on the margin and hairy in the centre; or when the centre is smooth, the rim chaffy, hairy or prickly.

14. Chaffy, (*paleaceum*), that is set with oblong, obtuse, short, hard leaves; these leaves are called chaff, (*paleæ*).

The scales of the catkin, stand on a slender receptacle, (*filiforme*). The fig is, properly speaking, not a fruit, but a closed receptacle, (*receptaculum clausum*), in which are contained the flowers, fig. 219, 220.

In Dorstenia, the common receptacle is said to be *placentiforme*, fig. 123. The Mithridatea *quadrifida* has a similar receptacle.

II. OF CLASSIFICATION.

§ 119.

The human mind is unable to take in the various forms of the vegetable kingdom at one view: it must therefore have recourse to some particular assistance in order to acquire more easily the knowledge it aspires at, and to satisfy its curiosity. It attains its object in the most perfect manner when it reduces its knowledge to a system.

System is a record of all the plants hitherto discovered, arranged according to certain characters, with their deviations. When a person has once accustomed himself to some system, his progress will be doubled, and he will form a much better judgement of plants than he was able to do before.

§ 120.

There have been men of high abilities who have maintained, that all nature might be reduced to system; there have, on the contrary, been other great men who have denied the truth of this position, and have disdained all systematic arrangement, or even the least trace of it. Others again, and indeed the greater number, believe that there is no real system of nature, but that there is a chain of being.

Nature connects the most multifarious bodies by their forms, their size, their colours and their qualities. Each particular body, each plant has some affinity with others. But who is able to declare the order followed by nature? All affinities and natural orders are but apparent traces of a natural system. By a more accurate investigation, we find those boasted affinities not so great, and the natural orders not so clear. We endeavour, by systematic divisions, to arrange bodies in straight lines; but nature forms in the whole an intricate and infinite ramification, which we are too short-sighted to perceive, and too superficial to fathom. Perhaps in some centuries hence, when every corner of the globe has been examined, and numerous experiments have distinguished what is true from what is false, we may be able to judge more soundly of the order of nature.

§ 121.

But though a true natural system has not been discovered, it cannot be denied that some plants are allied by such very striking resemblances, that they may be considered as belonging to natural classes. Those resemblances, however, extend but to few plants, and there are many wanting to connect one natural family with another. These affinities, however, have been sufficient to enable botanists to arrange plants by their external characters, and this arrangement has been called a Natural System, (*Systema naturale*).

Other botanists have founded their systems on the number, proportion and agreement of minute and not very obvious parts, and such a system has been called artificial, (*systema artificiale*).

Others again select the sexual parts as the distinctive characters, and found their system on the number and variety of these parts. This is called the Sexual System, (*systema sexuale*).

§ 122.

Some of those natural families of plants, which the beginner ought to be well acquainted with, are the following:

1. The FUNGI; these are distinguished from other plants by their peculiar form, which is commonly fleshy, coriaceous, or woody, fig. 4, 6, 7, 223, 224, 225.

2. The ALGAE come somewhat near in their appearance to other plants; but neither stem nor leaves are to be found in them. Their form is very various; sometimes they have the appearance of flour or fibres; or they resemble the fret-work in architecture, fig. 3, 226.

3. The MUSCI, Mosses. In these the external appearance is almost the same with that of other plants, but their fruit and leaves are different. They are divided into,

a. Musci frondosi: these have a capsule which is furnished with a lid, and the leaves are small, fig. 138.

b. The *Musci hepaitci:* these in general have no stem; their leaves grow larger, and lie flat. The capsule bursts into several valves, fig. 127.

4. The FILICES, Ferns, are plants that never push from the root more than one leaf on a footstalk, (some Indian species excepted), and the leaf at its evolution is generally rolled up in a spiral. Their fructification is either in a spike, (*spiciferæ*), fig. 9, or on the back of the leaf, (*epiphyllospermæ* s. *dorsifloræ*), fig. 15.; or lastly, on the root in the form of a knob, (*rhizospermæ*).

5. The GRAMINA, Grasses. These have their leaves long and slender, their stem, which is called straw, is commonly jointed, and each flower bears but one seed: the flower likewise is very different from that of other plants, fig. 34.

6. The LILIA, Lilies, have bulbous or tuberous roots, long, slender leaves, specious flowers, without calyx, or instead of it a spatha.

7. The PALMAE, palms; these have an arboreous stem, but never branches; the leaves rise from the stem, which is called *stipes.* The flowers issue from a spatha.

8. PLANTAE, plants are all that do not come under the above divisions; they are either Herbs, Undershrubs, Shrubs, or Trees.

a. Herbæ, are all such plants as bear flowers and seeds but once, and then die. They do this either in one year, and are then called Annuals, (*plantæ annuæ*); or they bear in the first year leaves, in the second flowers and seeds, and then die: these are called biennials, (*plantæ biennes.*)

b. Under-shrubs, (*suffrutices*): in these the stem perishes annually, but the root remains.

c. Shrubs, (*frutices*): of these the stem continues many years, and is divided below into branches.

d. Trees, (*arbores*): of these the stem endures for many years, and is divided at top into branches.

Climate and culture have great influence on these divisions; so that often trees and shrubs insensibly run into one another.

§ 123.

Before we proceed to treat of the different systems, it is necessary to explain what is meant by Class, Order, Genus, Species and Variety.

A System is first divided into classes and orders. In each system a certain part of plants, such as the flower, the fruit, &c. is assumed as the foundation, and upon that, classes, orders, and genera are constructed. When a particular investigated character is common to many plants, these plants make a Class, (*classis*). Should some of the plants, beside the particular character of the class, agree in another character, these form an Order, (*ordo*). And if a few of the plants, which already agree in two of the characters, are found to possess others in common, these are called a *Genus*. Each of the plants in this last division is called a *Species*. It is necessary in a species that it remain always the same from seed. A Variety, (*varietas*), is a species that differs only in colour, size, or in some accidental circumstance. From the seed the variety changes at last into the true species. Of this more in § 182.

§ 124.

From a good system we expect that the part selected, according to which the classes, orders and genera are framed, shall be easily seen, and without difficulty found; and that it shall be common to all plants, and not subject to variation. Besides, no system ought to be divided according to any other character than that first selected. No good system should have too many subdivisions, and, if possible, should only consist of classes and orders. The orders should likewise be founded only on one part.

§ 125.

For a beginner it is very convenient to be acquainted with several systems, especially if at the same time he knows the defects of each, that he may be able, by his own experience, to have recourse to that which particularly suits him. I shall here give a view of the principal systems, in the language in which they were originally written; and should any term occur which is not to be found in the preceding Terminology, I shall briefly explain it.

§ 126.

CAESALPINUS was the first botanist who invented a system. He selected the fruit, and the situation of the corculum, as the distinguishing characters. His system has fifteen classes, *viz.*

1. Arbores, corculo ex apice seminis.
2. ——— ——— a basi seminis.
3. Herbæ, solitariis seminibus.
4. ——— ——— baccis.
5. ——— ——— capsulis.
6. ——— binis seminibus.
7. ——— ——— capsulis.
8. ——— triplici principio, fibrosæ.
9. ——— ——— ——— bulbosæ.
10. ——— quaternis seminibus.
11. ——— pluribus seminibus. Anthemides.
12. ——— ——— ——— Cichoraceæ *s.* Acantaceæ.
13. ——— flore communi.
14. ——— folliculis.
15. ——— flore fructuque carentes.

This system is for our times, when such a multitude of plants have been discovered, no longer of use. Considered as the first attempt at system it is entitled to great consideration. The fruit is a very constant part, and this classification would be particularly commendable, if plants and trees had not been separated. In the two first classes trees are distinguished according to the situation of the corculum; the other classes are arranged according to the fruit of the plants. The eighth and ninth classes have a trilocular capsule, and are distinguished according to the situation of the corculum; the other classes are arranged according to the fruit of the plants. The eighth and ninth classes have a trilocular capsule, and are distinguished according as the root is either fibrous or bulbous. The eleventh, twelfth, and thirteenth classes contain the compound flowers, (§ 80, No. 3); the twelfth, semifloscular flowers, (§ 80, No. 1); the thirteenth, discoid flowers, (§ 80, No. 2). The fourteenth class contains such plants as bear several capsules together, as the ranunculus, anemone, &c. The last class includes Mosses, Algae, Fungi and Filices. The ancients believed that these plants carried neither flowers nor seeds.

§ 127.

Morison constructed his system according to the flower, and the external appearance of the plant. He has eighteen classes:

1. Lignosæ, Arbores.
2. ———— Frutices.
3. ———— Suffrutices.
4. Herbaceæ, Scandentes.
5. ———— Leguminosæ.
6. ———— Siliquosæ.
7. ———— Tricapsulares.
8. ———— a numero capsularum dictæ.
9. ———— Corymbiferæ.
10. ———— Lactescentes, *s.* papposæ.
11. ———— Culmiferæ *s.* Calmariæ.
12. ———— Umbelliferæ.

13. Herbaceæ, Tricoccæ.
14. ———— Galeatæ.
15. ———— Multicapsulares.
16. ———— Bacciferæ.
17. ———— Capillares.
18. ———— Heteroclitæ.

The defect of this system, as of all the old systems, consists in the various foundations of the division, and in separating trees and plants. By Suffrutices, MORISON means small shrubs, but not according to our definition, (§ 122). Even some moderns use the term *suffrutex* for a small shrub. The fourth class contains all twining plants, as the Cucurbita, Convolvulus, &c. The seventh class includes plants which have a trilocular capsule. In the eighth class are plants that have sometimes more, sometimes fewer cells in the capsules. The ninth class contains the compound flowers that have no pappus, or at least only a membranaceous one. In the tenth class are all the compound flowers that have a plumose, pilose, setaceous, &c. pappus. To the eleventh class belong all the grasses and plants allied to them; to the twelfth, the umbelliferous plants; to the thirteenth, those which have a trilocular capsule, and which seem to consist of three separate capsules, (§ 102, No. 5). The fourteenth class contains the ringent or labiated flowers; the seventeenth contains only the Filices; and the eighteenth includes the Mosses, Algae, Fungi and Corals. It is to be regretted that MORISON often arranges plants in a class to which they do not belong.

§ 128.

Hermann made use of the fruit, of the flower, and also, but on few occasions, of the external appearance, in framing his system.

Herbæ gymnospermæ.

1. Monospermæ.	Simplices.
2. ———	Compositæ.
3. Dispermæ.	Stellatæ.
4. ———	Umbellatæ.
5. Tetraspermæ.	Asperifoliæ.
6. ———	Verticillatæ.
7. Polyspermæ.	Gymnopolyspermæ.

Herbæ Angiospermæ.

8. Bulbosæ.	Tricapsulares.
9. Capsula unica.	Univasculares.
10. Capsulæ binæ.	Bivasculares.
11. ——— tres.	Trivasculares.
12. ——— quatuor.	Quadrivasculares.
13. ——— quinque.	Quinquevasculares.
14. Siliqua.	Siliquosæ.
15. Legumen.	Leguminosæ.
16. Multicapsulares.	Multivasculares.
17. Carnosæ.	Bacciferæ.
18. ———	Pomiferæ.

Herbæ Apetalæ.

19. Calyculatæ.	Apetalæ.
20. Glumosæ.	Stamineæ.
21. Nudæ.	Muscosæ.

Arbores.

22.	Incompletæ.	Juliferæ.
23.	Carnosæ.	Umbilicatæ.
24.	———	Non Umbilicatæ.
25.	Non carnosæ.	Fructu sicco.

This system is to be preferred to those already mentioned; only the separation of trees and plants is reprehensible. But to make it useful in the present times, it would need great amendment. The above enumeration of the classes renders any further explanation unnecessary.

§ 129.

Christopher Knaut has also chosen the fruit as the foundation of his system, but with this difference, that he has taken into account the number of the petals and the regularity of the flower. His system has a great resemblance to the first of Ray.

§ 130.

Boerhaave has constructed his system partly from that of Hermann, Tournefort and Ray. He too has separated trees and plants. The number of the capsules, of the petals, and of the cotyledons is made use of.

§ 131.

Ray conjoins fruit, flower, and external appearance, like his predecessors. As his system has something peculiar, I shall here detail it.

1. Herbæ,

1.	Herbæ,	Submarinæ.
2.	——	Fungi.
3.	——	Musci.
4.	——	Capillares.
5.	——	Apetalæ.
6.	——	Planipetalæ.
7.	——	Discoideæ.
8.	——	Corymbiferæ.
9.	——	Capitatæ.
10.	——	Solitario semine.
11.	——	Umbelliferæ.
12.	——	Stellatæ.
13.	——	Asperifoliæ.
14.	——	Verticillatæ.
15.	——	Polyspermæ.
16.	——	Pomiferæ.
17.	——	Bacciferæ.
18.	——	Multisiliquæ.
19.	——	Monopetalæ.
20.	——	Di—Tripetalæ.
21.	——	Siliquosæ.
22.	——	Leguminosæ.
23.	——	Pentapetalæ.
24.	——	Floriferæ.
25.	——	Stamineæ.
26.	——	Anomalæ.
27.	——	Arundinaceæ.
28.	Arbores,	Apetalæ.
29.	———	Fructu umbilicato.
30.	———	—— non umbilicato.
31.	———	—— sicco.

32. Arbores, Fructu siliquoso.
33. ——— Anomalæ.

The old system of Ray has only twenty-five classes, and is consequently more imperfect than this improved one. He still retains the old division of trees and plants. In the first class stand all the Fuci, Zoophytes and Corals. In the fifth all plants that have no petals; in the sixth the semifloscular flowers, (§ 80, No. 1.); in the seventh the discoid and radiate flowers that have a pilose pappus; in the eighth class are those same flowers, but which have no pappus; and in the ninth class stand all those capitate compound flowers which have a membranaceous pappus. The twelfth class contains plants with verticillated flowers, that at the same time have a corolla of four petals and two naked seeds. Under the thirteenth class are arranged all the rough-leaved plants, that bear a monopetalous tubular corolla, and four naked seeds. To the fourteenth belong the labiated or ringent flowers. In the twenty-fourth class stand all the Lilies. To the twenty-fifth belong all the Grasses, and to the twenty-sixth those which cannot be reduced under any of the foregoing.

§ 132.

Camellus has attempted a very singular system, from the valves of the capsule and their number. It is not, however, on account of its shortness, of great use.

1. Pericarpia, Afora.
2. ——— Unifora.

3. Pericarpia, Bifora.
4. ---------- Trifora.
5. ---------- Tetrafora.
6. ---------- Pentafora.
7. ---------- Hexafora.

§ 133.

Rivinus selects only the corolla, the regularity of the petals, and their number.

Flores regulares.

1. Monopetali.
2. Dipetali.
3. Tripetali.
4. Tetrapetali.
5. Pentapetali.
6. Hexapetali.
7. Polypetali.

Flores compositi.

8. Ex flosculis regularibus.
9. Ex flosculis regularibus et irregularibus.
10. Ex flosculis irregularibus.

Flores irregulares.

11. Monopetali.
12. Dipetali.
13. Tripetali.
14. Tetrapetali.
15. Pentapetali.
16. Hexapetali.

17. Polypetali.
18. Flores incompleti.—Imperfecti.

This system is very easily understood, and the selected character is to be found without any trouble. But the regularity of the corolla, which often varies in the different species of a genus, and the number of petals, which likewise not unfrequently vary, make it difficult in practice. The orders are taken from the fruit according as it is naked, *(fructus nudus)*, or contained in a pericarp; and this last is distinguished according as it is dry *(pericarpium siccum)*, or fleshy *(pericarpium carnosum)*.

§ 134.

Christian Knaut has adopted Rivinus's method almost unchanged, but in some degree reversed. The classes he forms from the number of the petals, and his subdivisions he takes from their regularity or irregularity. But he denied that there were any flowers without a corolla, or that there was such a thing as naked seeds.

§ 135.

The System of Tournefort was for a considerable time the favourite system of all botanists, and it deserves particular attention.

Herbæ et suffrutices.

1. Floribus monopetalis campaniformibus.
2. ——— ——— infundibuliformibus et rotatis.
3. ——— ——— anomalis.

4. Floribus monopetalis labiatis.
5. ——— polypetalis cruciformibus.
6. ——— ——— rosaceis.
7. ——— ——— umbellatis.
8. ——— ——— caryophyllæis.
9. ——— ——— liliaceis.
10. ——— ——— papilionaceis.
11. ——— ——— anomalis.
12. ——— flosculosis.
13. ——— semiflosculosis.
14. ——— radiatis.
15. ——— apetalis et stamineis.
16. Qui floribus carent et semine donantur.
17. Quorum flores et fructus conspicui desiderantur.

Arbores et frutices.

18. Floribus apetalis.
19. ——— amentaceis.
20. ——— monopetalis.
21. ——— rosaceis.
22. ——— papilionaceis.

The form of the corolla, which Tournefort properly employs as the ground-work of his system, appears to make it very easy and intelligible. But the figure of the corolla is so various that it is often with difficulty described. Besides, some species of corolla so much resemble others that they are not easily distinguished. It is on this account chiefly that Tournefort's system is not used in these days. The orders in his method are taken from the style and from the fruit. When the germen is under the flower, he says "*calyx abiit in fructum*"; when it is included in the flower he says "*pistillum abiit in* "*fructum.*" The fruit is also more accurately distinguished, as it is a capsule, berry, &c.

§ 136.

We shall here pass by several of the less important systems that are merely alterations of the foregoing. These alterations consist sometimes of a single circumstance, of which the former authors had taken no notice. Of this PONTEDERA may serve as an instance. He took Tournefort's system, and combining it with that of Rivinus, only separated the plants that bear buds from those that have none. Another more worthy of consideration is that of MAGNOLIUS; though it too is of little use in practice. He forms his classes intirely on the calyx. Many similar systems may be found in ADANSON, an eminent naturalist, who has constructed upwards of sixty systems, and has shewn evidently that many more might be imagined, if science was to derive any benefit from the labour.

§ 137.

The systems we have detailed are either built on the fruit or the flower, and their parts: but none before GLEDITSCH had attempted one on the situation of the stamina. His classes are the following:

1. Thalamostemonis.
2. Petalostemonis.
3. Calycostemonis.

4. Stylostemonis.
5. Cryptostemonis.

The insertion of the stamina here form the classes: in the first class they stand on the receptacle; in the second on the corolla; in the third on the calyx; in the fourth on the style; and to the fifth class belong plants whose flowers are inconspicuous, as the Filices, Musci, Algæ and Fungi. The orders are formed according to the number of the antheræ; that is, whether they are one or more in a single flower, *viz.* Monantheræ, Diantheræ, &c. But as there are so few classes, it is obvious that the orders must have many subdivisions; and this is the only objection to this, otherwise, very elegant system, which indeed stands in the way of its further usefulness.

The same system has been lately somewhat changed by Monch. His classes are,

1. Thalamostemon.
2. Petalostemon.
3. Parapetalostemon, *i. e.* when the stamina stand upon leaves similar to petals, which are found in the corolla.
4. Calycostemon.
5. Allagostemon, when the stamina stand alternately on the calyx and petals.
6. Stylostemon, when they stand on the style.
7. Stigmatostemon, when they are inserted in the stigma.
8. Cryptostemon.

The orders he has taken from the differences in the fruit; but as some classes were too large, he was obliged to take his subdivisions from other parts of the flower.

§ 138.

HALLER endeavoured, very ingeniously, to frame a natural system on the cotyledons, the calyx, the corolla, the stamina, and the sexes of plants. His classes, of which he afterwards found it necessary to make some little alteration, are the following:

1. Fungi.
2. Musci.
3. Epiphyllospermæ.
4. Apetalæ.
5. Gramina.
6. Graminibus affinia.
7. Monocotyledones Petaloideæ.
8. Polystemones.
9. Diplostemones.
10. Hostemones.
11. Mejostemones.
12. Staminibus sesquialteris.
13. ——— sesquitertiis.
14. ——— quatuor, ringentes.
15. Congregatæ.

To the third class belong all the Filices. To the seventh all the Lilies: In the eighth class stand all those plants whose filaments exceed in number the segments or petals of the corolla three or four times. To the ninth class belong all those plants which have twice as many filaments as there are segments or petals in the corolla. To the tenth belong those that have the same number of filaments as there are segments or petals in the corolla. In the elventh class are included all those plants whose filaments are fewer in number than the segments or petals of the corolla. To the twelfth belong all the cruciform plants; to the thirteenth, all the papilionaceous; and to the fourteenth, the ringent or labiated flowers with four stamina. The last class contains all the compound flowers. The orders in this system are taken from all parts of the flower and of the fruit.

Royen and Wachendorf have constructed similar systems, the first of which deserves the preference. But all these systems are attended with difficulty, on account of the various parts of plants which we must have constantly in view, and the great number of subdivisions which they necessarily require.

§ 139.

Linnaeus, in his System, has fixed upon the stamina as the foundation of his divisions.

1. Monandria.
2. Diandria.
3. Triandria.
4. Tetrandria.
5. Pentandria.
6. Hexandria.
7. Heptandria.
8. Octandria.
9. Enneandria.
10. Decandria.
11. Dodecandria.
12. Icosandria.
13. Polyandria.
14. Didynamia.
15. Tetradynamia.
16. Monadelphia.
17. Diadelphia.
18. Polyadelphia.
19. Syngenesia.
20. Gynandria.
21. Monoecia.
22. Dioecia.
23. Polygamia.
24. Cryptogamia.

From the first to the tenth class the stamina are numbered, fig. 95, 79, 115, 81, 153, 154, 110, 126. To the eleventh class belong all the plants that have above above ten to nineteen stamina. To the twelfth class those plants which have many stamina inserted in the calyx, fig. 52, 53. The thirteenth class contains plants that have a great number of stamina from twenty to one thousand in one flower, fig. 116. The fourteenth consists of plants that have four stamina in one flower, of which two are longer than the rest, fig. 50, 51. In the fifteenth class stand those which have six stamina, of which two are shorter than the rest, fig. 145, 149. The sixteenth class contains plants whose filaments are connected and form a cylinder, fig. 56, 57. In the seventeenth class stand those plants whose filaments are united in two parcels, fig. 108, 109. To the eighteenth class belong those plants whose filaments are united in several parcels, fig. 150. In the nineteenth class stand those plants whose antheræ are united in a cylinder. The twentieth class consists of those plants whose stamina stand upon the style; the twenty-first consists of flowers of different sexes, namely, male and female on one plant; the twenty-second, of male and female flowers, but so divided that one plant bears only male flowers, the other only female; the twenty-third has flowers of both sexes and hermaphrodite flowers together, so that the plant contains either male and hermaphrodite flowers or female and hermaphrodite flowers. To the last class belong all plants whose flowers are not visible to the naked eye, these are the Filices, Musci, Algæ and Fungi.

§ 140.

The Orders in most of the classes are taken from the style, in some from the fruit, and in the last classes from the filaments. From the first to the thirteenth class the orders are taken from the style, viz. *monogynia* when there is only one style in the flower, fig. 114, 115, 116, 144, 153, &c. two, three, four, &c. styled, (*di*, *tri*, *tetra*, *&c. polygynia*), according to their number, fig. 135. In general we count to six, and then say *polygynia*. If there should be several germens and but one style, the style only is numbered. The orders are never taken from the germens except when the style is wanting. The Orders of the fourteenth class are taken from the fruit; there are two, viz. *Gymnospermia* when the seeds are naked, and *Angiospermia* when they are contained in a pericarp. Those of the fifteenth class are, like the foregoing, taken from the fruit, with this difference, that here there are no naked seeds but a Siliqua, and the Orders are named according to the size of this, *siliculosa* and *siliquosa*. In the sixteenth, seventeenth, eighteenth, twentieth, twenty-first and twenty-second classes, the Orders are denominated according to the number of the stamina; in the 16th, 17th, 18th and 20th, they are numbered from Diandria upwards; in the 21st and 22d from Monandria.

The 19th Class contains none but compound flowers, except a very few. Linnæus considers these flowers as a Polygamy, (*polygamia*), and prefixes this word to the name of each Order in which the compound flowers are contained; for example,

Polygamia æquales, when all the florets which a compound flower contains are hermaphrodites, and similar in form, whether they be ligulate or tubular, fig. 85, 143.

Polygamia superflua, when the compound flower is radiate, the disc bearing hermaphrodite florets, and the ray, fertile florets.

Polygamia frustranea, when the compound flower is radiate, the disc consisting of fertile, hermaphrodite florets, and the ray of barren female florets.

Polygamia necessaria, when the compound flower is radiate, the disc consisting of barren hermaphrodite florets, the ray of fertile female florets.

Polygamia segregata, when in a compound flower, besides the common perianth, each floret is furnished with its own particular calyx.

Monogamia is an Order containing all the plants which according to strict system belong to this class, though they are not compound flowers.

The plants of the 21st and 22d classes, as we have said already, are divided into Orders according to the number of the stamina; but besides these, there are two orders taken from the connection of the filaments and antheræ, namely, *Monadelphia* and *Syngenesia*. The last Order of both classes is called *Gynandria;* not because in the plants which belong to it, the stamina stand upon the style; but because in the male flowers there is a production resembling a style to which the stamina are attached. This production Linnæus considers as an imperfect pistillum.

In the 23d class the Orders are called *Monoecia*, *Dioecia* and *Trioecia*. The last class has the following Orders, *Filices*, *Musci*, *Algae* and *Fungi*, (§ 122).

§ 141.

From the aforegoing analysis it will be seen that the Linnæan system consists of an artificial and sexual arrangement, and that it does not answer the idea, we have given above, (§ 124), of a perfect system. But till such a one is found out, a system partly natural, partly artificial is the best; we must, however, as we cannot deny the usefulness of Linnæus's system, point out its defects.

Linnæus endeavoured, from the number of the stamina, their various lengths, and different modes of connection, to unite a natural classification with an artificial one. Hence arose some faults, which would not have happened had he, at the same time, made use of the corolla as a character. For instance, in the fourteenth class are contained the labiated and ringent flowers; but because Linnæus characterised it from the four stamina, two of which are shorter; there are some of these plants which must stand in the second class, and others in the fourth, though they properly belong to this class. In the same manner, all the papilionaceous flowers are referred to the seventeenth class; but the assumed character, *viz.* that the filaments are united into two sets, is not to be found in all these plants: Many have the filaments united in one cylinder; and in the tenth class stand many plants with papilionaceous flowers. These two faults are not the greatest which may be attributed to this system: it is a more important objection that Linnæus has numbered the stamina in the first classes without attending to their insertion, while in the twelfth he remarks that they are inserted in the calyx, and in the twentieth, that they stand on the pistillum. In the nineteenth class are comprehended all the compound flowers, and yet he drags into the last order of this class other plants whose antheræ are only sometimes united. It is also to be regretted, that in the 21st, 22d and 23d classes Linnæus has taken notice of different sexes in the same plant, which he had not done before; there being many plants in the former classes that properly belong to these.

§ 142.

These defects and some others, from which no system can easily be exempted, have suggested to several botanists the possibility of correcting them and making the system more useful. Among all the improvements of the Linnæan system, those by THUNBERG, seem to be the chief. He has reduced the number of classes to twenty, by referring the plants of the 20th, 21st, 22d and 23d classes to others, according to the number or connection of the stamina.

All the plants which stand in the 20th class ought to have the stamina placed upon the style; but the most of the plants arranged by Linnæus in this class want these characters, the genus of Orchis alone excepted, (§ 143, No. 7). The three following classes are not always constant with regard to sex; a difference of climate will sometimes remove a plant from the class Monoecia to that of Polygamia.

LILJEBAD has made the following changes on the Linnæan system. He joins the 7th, 8th and 9th classes to the 10th. His Decandria thus contains the Heptandria, Octandria, Enneandria and Decandria of Linnæus. The 11th class he joins to the 13th. The 18th, 21st, 22d, and 23d he includes in one. Thus his system contains only sixteen classes, *viz.*

1. Monandria.
2. Diandria.
3. Triandria.
4. Tetrandria.
5. Pentandria.
6. Hexandria.
7. Decandria.
8. Icosandria.
9. Polyandria.
10. Gynandria.
11. Didynamia.
12. Tetradynamia.
13. Monadelphia.
14. Diadelphia.
15. Syngenesia.
16. Cryptogamia.

Some other botanists have changed the orders of the 19th class, by leaving out the word *Polygamia*, and removing the plants of the order Monogamia to other classes.

But this order of the 19th class ought to be altogether suppressed; because the genera belonging to it have nothing in common with the other syngenesious flowers but the united antheræ, which other genera, for instance the solanum, possess likewise. If this order be taken away the class becomes perfectly natural.

SCHREBER, in the last edition of the Genera Plantarum, has changed the Orders of the 24th class, as follows:

1. Miscellaneæ.
2. Filices.
3. Musci.
4. Hepaticæ.
5. Algae.
6. Fungi.

It would be superfluous here to take notice of other alterations which do not tend to the improvement of the science.

§ 143.

Besides the knowledge of different systems, it is very useful for a beginner to have some idea of the natural affinities of plants. He is thus, in the investigation of unknown plants, more easily led into the right track. We are indeed far behind in this branch of knowledge, and the little we know is very imperfect: but that little may be of great assistance to us in the investigation of plants, because botanists in their descriptions often make use of expressions by which plants of particular allied families are ascertained. Linnæus has left us the following arrangement of Natural Orders:

1. *Palmæ*, § 122, 7.

2. *Piperitæ.* The flowers of this order are crowded into a close spike, as Piper, Arum, &c.

3. *Calmariæ.* To this order belong all the Grass-like plants, which differ from the true Grasses

by their unjointed stem, such as Typha, Sparganium, Carex, Schoenus, &c.

4. *Gramina.* All the proper Grasses, § 122, 5.

5. *Tripetaloideæ.* These have either three petals, or the calyx has three foliola, as in Juncus, Alisma, &c.

6. *Ensatæ.* Lilies, whose leaves are ensiform or sword-shaped, and their corolla monopetalous, are of this order, as Iris, Gladiolus, &c.

7. *Orchideæ,* whose roots are fleshy, but the flowers are either furnished with a spur or with a corolla of a singular construction. The filaments and style are obscure, and the germen is below the flower.

8. *Scitamineæ* have a herbaceous stem, very broad leaves, a three-cornered, or at least a blunt-cornered germen, under a liliaceous corolla; as in Amomum, Canna, Musa, &c.

9. *Spathaceæ,* are Lilies, which have their flowers contained in a large spatha; as in Allium, Narcissus, &c.

10. *Coronariæ,* Lilies that have no spatha, but have a corolla with six petals; as in Tulipa, Ornithogalum, Bromelia, &c.

11. *Sarmentaceæ,* that have very weak stems and liliaceous flowers, as Gloriosa, Smilax, Asparagus, &c.

12. *Oleraceæ,* that have plain flowers, *i. e.* of no beauty, as in Blitum, Spinacia, Petiveria, Herniaria, Rumex, &c.

13. *Succulentæ,* that have very thick, fleshy leaves, as in Cactus, Mesembryanthemum, &c.

14. *Gruinales* have a pentapetalous corolla, seve-

ral pistils, and a long pointed capsule, as in Linum, Geranium, Oxalis, &c.

15. *Inundatæ*, grow under water with flowers of no beauty, as Hippuris, Zanichellia, Ruppia, Potamogeton, &c.

16. *Calycifloræ*, that have only a calyx, in which the stamina are inserted, as in Eleagnus, Osyris, Hippophae, &c.

17. *Calycanthemæ*. In these the calyx is seated on the germen or grows to it, and the flowers are very beautiful, as in Epilobium, Gaura, Oenothera, Lythrum, &c.

18. *Bicornes*, have the antheræ furnished with two long, straight points or horns, as in Ledum, Vaccinium, Erica, Pyrola, &c.

19. *Hesperides*, these have strong ever-green leaves, sweet-smelling flowers, and many stamina, as in Myrtus, Psidium, Eugenia, &c.

20. *Rotaceæ*, bearing a wheel-shaped corolla, as in Anagallis, Lysimachia, Phlox, &c.

21. *Preciæ*, that have specious flowers which appear early in the spring, as Primula, Androsace, Diapensia, &c.

22. *Caryophylleæ*, those having a monophyllous tubular calyx, a pentapetalous corolla, ten stamina, and long ungues to the petals, as Dianthus, Saponaria, Agrostemma, &c.

23. *Trihilatæ*, these have a style with three stigmata, and winged or inflated capsules, as Melia, Banisteria, &c.

24. *Corydales*. The flowers of these have either

a spur, (*calcaratæ*), or are of a singular form, as in Epimedium, Pinguicula, &c.

25. *Putamineæ*, that bear fruit in a hard shell, as in Capparis, Morisonia, &c.

26. *Multisiliquæ*, bearing many siliques, as in Paeonia, Trollius, Caltha, &c.

27. *Rhoeadeæ*, that have a caducous calyx, and a capsule or silique, as in Argemone, Chelidonium, Papaver, &c.

28. *Luridæ*, that have commonly a monopetalous corolla, a pericarpium and five stamina. They are endowed for the most part with poisonous or dangerous qualities, as Datura, Solanum, &c.

29. *Campanaceæ;* these have bell-shaped flowers, as the Campanula, Convolvulus, &c.

30. *Contortæ;* in these the corolla is twisted, or the stamina and pistils are covered with leaves resembling petals; as in Nerium, Asclepias, &c.

31. *Veprecula*, have a monophyllous calyx, coloured like a corolla; as in Dirca, Daphne, Gnidia, &c.

32. *Papilionaceæ;* these include the papilionaceous flowers, (§ 76, No. 7), as Vicia, Pisum, Phaseolus, &c.

33. *Lomentaceæ;* these bear a legumen or lomentum, but not a papilionaceous flower, as Mimosa, Cassia, Ceratonia, Gleditsia, &c.

34. *Cucurbitaceæ*, whose fruit is a pepo or pumpkin, and in general they have united stamina, as in Cucumis, Bryonia, Passiflora, &c.

35. *Senticosæ* have a polypetalous corolla, and the fruit consists of a number of seeds, either naked or slightly covered. The leaves and stems

are either hairy or prickly, as in Potentilla, Alchemilla, Rubus, Rosa, &c.

36. *Pomaceæ*, have many stamina inserted in the calyx, and a drupa or apple for fruit, as Sorbus, Amygdalus, Pyrus, &c.

37. *Columniferæ;* in these the stamina unite and form a long tube, as in Malva, Althæa, Hibiscus, &c.

38. *Tricoccæ*, bearing a trilocular capsule, § 102, No. 5, as Euphorbia, Tragia, Ricinus, &c.

39. *Siliquosæ*, bearing a silique or a silicle, § 108, as Thlaspi, Draba, Raphanus, &c.

40. *Personatæ*, bearing a masked or personate flower, (§ 75, No. 13), as in Antirrhinum, &c.

41. *Asperifoliæ;* these have four naked seeds, a monopetalous corolla, five stamina, and rough leaves, as in Echium, Symphytum, Anchusa, &c.

42. *Verticillatæ;* these have labiated or ringent flowers, as Thymus, Monarda, Nepeta, &c.

43. *Dumosæ;* these are shrubby plants, and their stem is furnished with a soft medulla or pith; their flowers are small, the petals with four or five laciniæ, as in Viburnum, Rhamnus, Euonymus, &c.

44. *Sepiariæ;* shrubs, commonly with a tubular and laciniated corolla, and few stamina, in general only two, as in Syringa, Ligustrum, Jasminum, Fraxinus, &c.

45. *Umbellatæ*, bearing an umbel of flowers, a pentapetalous corolla, five stamina, two styles, and two naked seeds; as in Apium, Pastinaca, Daucus, &c.

46. *Hederaceæ;* these have a quinquefid corolla, five or ten stamina, and a fruit like a berry, on a

compound racemus; as in Hedera, Panax, Vitis, Cissus, Aralia, Zanthoxylon.

47. *Stellatæ;* these have a quadrifid corolla, four stamina, and two naked seeds. The leaves are commonly verticillated; as in Galium, Asperula, Valantia, &c.

48. *Aggregatae;* these appear like compound flowers, but have no united antheræ; as Scabiosa, Cephalanthus, &c.

49. *Compositæ;* this order contains all the compound flowers; *vid.* § 76.

50. *Amentaceæ;* this contains those plants whose fruit is a catkin; *vid.* § 64.

51. *Coniferæ;* this contains those that bear a strobilus, § 113; as Pinus, Juniperus, &c.

52. *Coadunatæ;* those which bear several berries or similar fruit united in one, as in Annona, Uvaria, Magnolia, &c.

53. *Scabridæ,* that bear rough leaves and flowers of no beauty, as Ficus, Urtica, Parietaria, Cannabis, &c.

54. *Miscellaneae;* to this order belong all those plants which cannot be referred to one or other of the aforegoing.

55. *Filices,* § 122, No. 4.

56. Musci, § 122, No. 3.

57. Algae, § 122, No. 2.

58. Fungi, § 122, No. 1.

Many of these natural families are very artificial, and some of them quite improper; but most of them have in their external appearance a great resemblance, which we easily comprehend, but which it is not easy to describe. Some of these natural orders have been improved and extended. The most successful labourers on the subject have been BATSCH and JUSSIEU, but especially the latter.

BATSCH has established 77 families, which, with a few exceptions, are pretty natural. JUSSIEU, who had an opportunity of seeing a much greater number of plants, has described 100 families.

§ 144.

The above may suffice to give the beginner a slight idea of the most important systems: a general view will shew us what remains to be done, and will convince us, that in the innumerable and endless varieties in the structure of plants, human ingenuity will never be able to contrive a perfect system.

III. BOTANICAL APHORISMS.

§ 145.

The true knowledge of Plants consists in the art of arranging, distinguishing, and naming them; and this art depends on the establishment of fixed rules, drawn from nature herself. The art of arranging plants is called System or Classification, of which we have treated in the preceding chapter; but that of distinguishing them must be further elucidated. For this purpose we must have an accurate knowledge of the Terminology, that we may be able to apply it properly, and to employ the rules which have been framed from a consideration of the structure of plants. This knowledge is to be acquired by an accurate investigation of flowers and a frequent inspection of plants generally considered. Method, (*methodus*), or the knowledge of plants from a consideration of the flower and its internal structure, is the proper business of a botanist; but the knowledge of the external figure, (*habitus*), is an assistance for facilitating the former, which he must on no account neglect.

§ 146.

The flower and fruit are the most constant parts of plants, and therefore on them should a System be built, and from them should the characters be selected. Some botanists have employed the leaves for this purpose; but experience shews how fallacious such a system proves. As the flower is the chief foundation of System, it affords likewise characters for establishing the Genera. The Species, however, must be distinguished by other characters than those taken from the flower.

§ 147.

The first rule, which naturally arises from the foregoing observations, is this, that the characters of the class must never be the same with those of the orders, nor the characters of the orders the same with those of the genera; but that the genera, which stand under one order and class, must possess the characters of these without exception; as for instance the potatoe, *Solanum tuberosum.* This plant stands in the fifth class of the System of Linnæus and first order: the characters of the fifth class are five stamina, and of the first order one style: the genus Solanum has the following characters: a quinquefid calyx, a wheel-shaped corolla, and a bilocular berry with many seeds. Thus if we place the discriminating character of the genus in its having five stamina and one style we would transgress the rule, for these characters are common not only to the genus Solanum, but to all those plants which stand under the same class and order.

§ 148.

GENUS is a number of plants which agree with one another in the structure of the flower and fruit, (§ 123). To distinguish the genera, we describe the flower and fruit, and such description is called the *character :* this is threefold, the natural, the factitious and essential, (*character naturalis, factitius, et essentialis*).

The natural character, (*character naturalis*), is a description at large of the flower and fruit of a plant, made according to the rules of Terminology, and serving for all the plants of a genus. Such a description it is very difficult to make; but when once accomplished, it tends to the perpetual ascertainment of the whole.

The essential character, (*character essentialis*), is a very short description of the whole genus, which contains only the character which essentially distinguishes it from every other.

The factitious character, (*character factitius*), is an essential chsracter, but where the number of the parts or some other circumstances, not of essential importance, are taken into it.

The essential character is of great importance in the accurate investigation of a plant, and when it is obvious and distinct it throws great light on the knowledge of plants. The factitious character is only to be used when genera contain too great a number of species, so that it becomes necessary to subdivide them; but where it is possible this ought to be avoided.

The essential and artificial character must be included in the natural; when this is not the case some of them must be defective.

Keeping our former example of the Solanum, we shall, in technical language, exhibit its characters.

SOLANUM.

CALYX, perianthium monophyllum, quinquefidum, erectum, acutum, persistens.

COROLLA, monopetala rotata. Tubus brevissimus. Limbus magnus quinquefidus, reflexo-planus, plicatus.

STAMINA, filamenta quinque, subulata, minima. Antheræ oblongæ, conniventes, subcoalitæ, apice poris duobus dehiscentes.

PISTILLUM, germen subrotundum. Stylus filiformis staminibus longior. Stigma obtusum.

PERICARPIUM, bacca subrotunda, glabra, apice punctato-notata, bilocularis. Receptaculo utrinque convexo carnoso.

SEMINA plurima subrotunda, nidulantia.

The above extended description is called a natural character, and is taken from the plant: any varieties of species are generally described separately. When we compare this natural character of the Solanum, with others of the same class and order, particularly with the allied genera of Capsicum, Physalis, &c. the following discriminating character arises:

SOLANUM.

Corolla rotata. Antheræ subcoalitæ, apice poro gemino dehiscentes. Bacca bilocularis.

This essential character will easily distinguish the genus Solanum from the rest. But suppose there was found a plant which had all these characters, but had a berry that was quadrilocular; if we were to make of this plant a separate genus, the character would be factitious; for, as we shall shew afterwards (§ 159, 160), the plant does notwithstanding belong to the genus Solanum.

§ 149.

Nature has connected, as we have seen, (§ 120), each particular plant with others, by certain affinities or resemblances. These resemblances are the foundation of the genera. But it is obvious that on this account the genera are not really in nature, but imagined by botanists as assistances to the knowledge of plants. Genera must be founded only on the flower and fruit; but the resemblances which we observe in plants are not confined merely to these, but are found in every other part of the plant.

§ 150.

The establishment of genera is a necessary step in the science; and to attain the knowledge of them we must attentively consider the whole structure of the flower and of the fruit. This structure is either natural, (*structura naturalissima*), or varied, (*differens*), or lastly, particular, (*singularis*).

§ 151.

The structure is to be considered according to its number, (*numerus*); figure, (*figura*); situation, (*situs*); and proportion, (*proportio*): and by these we observe whether it is natural, varied, or particular. In genera we must always be attentive to number, figure, situation and proportion; because without these no genus can be properly ascertained. On these are founded all the genera and most of the rules which, in the sequel, I shall lay down.

§ 152.

The natural structure, (*structura naturalissima*), is that form of the fruit and flower which is most frequent. In the natural character it is not used; for it serves only as a rule for the other kinds of structure. The following is the most natural structure of the flower.

The calyx is green, shorter than the corolla, and thicker; the corolla is tender, easily falls off, and is surrounded by the calyx. The stamina stand within the corolla, the antheræ stand erect upon the filaments, the pistillum is in the middle of the flower. As to number, the calyx and corolla are for the most part divided into five laciniæ, the stamina are five with one style. The laciniæ or foliola of the calyx and corolla are in general equal in number with the stamina. The fruit always

ways corresponds with the style; if there is but one pistillum, the fruit is unilocular; if there are more, there are also cells in the pericarp.

The form of the calyx in general is a cup with erect foliola; the flower is commonly more or less funnel-shaped; the stamina pointed; the pistillum is furnished with a slender and pointed style with a simple stigma.

With regard to proportion, the calyx is often about a third shorter than the corolla; the stamina and style are hardly longer than the calyx. As to situation, the calyx incloses the corolla and the petals are alternate with the foliola of the calyx. The stamina stand opposite to those foliola. The pistillum stands on the top of the germen. The seeds rest on the receptacle.

In a natural structure it is further observable, that a monopetalous corolla has a monophyllous calyx, and that a polypetalous corolla has a polyphyllous calyx. The corolla and calyx are seated on the receptacle. In a polypetalous corolla the stamina stand upon the receptacle; in a monopetalous, they are inserted in the corolla itself.

This natural character ought never to enter into descriptions. It would, for example, in the natural character of the Solanum, (§ 148), be quite superfluous, to say, *Calyx corolla minor, viridis, foliaceus, corolla tenera, antheræ pulvere flavo farctæ, germen post florescentiam intumescens, &c.*; because all these circumstances are supposed in a natural description, where we expect to find only discriminating characters.

§ 153.

Our botanical knowledge would be very limited if nature confined herself to the natural structure, and had made all flowers and fruits according to one form. But the contrary is the case, and we are therefore enabled to acquire a more extensive acquaintance with the vegetable kingdom. Of this the Terminology will serve as a proof; it points out to us the deviations of plants from the natural structure; and these deviations, when we consider merely the flower and fruit, exhibit the varied structure, (*structura differens*), of plants. This structure is the foundation of every genus; all genera and their characters depend on this structure and the natural one.

§ 154.

The particular structure, (*structura singularis*), is that which is directly opposite to the natural one, and affords the most beautiful characters. When, for example, in a monopetalous corolla the stamina stand upon the receptacle instead of being inserted in the corolla, we call that a singular structure; or when the nectaria stand between the corolla and the calyx, as in Wildenowia, instead of standing, as is usual, between the corolla and the stamina.

Some other examples are delineated on the fifth plate, which I shall here more particularly mention:

The genus Cucullaria, fig. 112, 113, shews an orchideous flower, with the anthera inserted into a petal.

The genus Rupala, fig. 115, has the filaments standing at the point of the foliola of the calyx.

The genus Lacis, fig. 116, has neither calyx nor corolla, but a very simple flower, consisting of many stamina and one style.

Dimorpha, fig. 126, appears with a single petal, rolled up on the side.

Dorstenia, fig. 123, has a common receptacle, set close with male flowers, fig. 124, and with female flowers, fig. 125.; and has a particular calyx.

Sterculia, fig. 144, has a germen raised on a long footstalk, that is set with united filaments.

In the same manner are found the flowers of Periploca, Asclepias and Stapelia; fig. 83, 88, 89, 90, 91, 92, 98, 99, 100. These are furnished with particular organs which we have described with the Nectaria, and which quite cover the stamina with the style. The stamina are singularly formed, the filaments are attached like forks to a cartilaginous body, and bear at the tip of each an anthera.

Two genera are remarkable for the particular structure of the floral leaf, namely Ascium and Ruyschia. The former, fig. 117, has an ascidiform stipitate floral leaf, (*bractea ascidiformis stipitata*), which stands close behind the flower. The latter has an ascidiform sessile bractea, (*bractea ascidiformis sessilis*), furnished with two lobes, (*biloba*), which surround the flower behind.

These few instances are sufficient to shew that the flowers above-mentioned have a particular structure, altogether different from the common one, Many other examples will be found by an attentive dissection of flowers.

§ 155.

From the singular structure of plants may be deduced the aphorism, that those genera, which have this singular structure, are more easily ascertained than those that come near to the natural structure. This last extends over all the natural families of the vegetable kingdom. The umbelliferous plants, the lilies, the papilionaceous flowers, the cruciform and compound flowers, are, on account of the similarity of their structure, with difficulty distinguished. For ascertaining with facility the genera of every kind, rules have been laid down which must be adapted to new discovered plants. There are rules which in general are applicable to all plants, and others that regard only particular families. But before proceeding to these we shall endeavour more accurately to define the calyx.

§ 156.

In some flowers that have but one external cover, it is difficult to determine whether that cover is calyx or corolla. Various methods have been devised to ascertain this, but never with success. Indeed we do not apply to any purpose the difference between calyx and corolla; we can give them both the same name; we may call the calyx the outer, and the corolla the inner cover. This would in uncertain cases remove any doubt of what was calyx and what corolla; but we could not in description give so proper an idea of the figure of plants. It is therefore better to distinguish these organs, and in doubtful cases to substitute something else. According to Linnæus, when there is but one part present, and the stamina stand opposite to the laciniæ, that part is considered as calyx: but when they stand alternately with the laciniæ, it is said to be a corolla. There are however calyxes to be found where the stamina stand alternately with the laciniæ; and plants that have a greater number of stamina than of laciniæ or foliola of the calyx; it is therefore by this rule impossible to say whether the part be a calyx or corolla. Scopoli thinks that when only one part is present, it should be considered as a calyx. This rule errs against all analogy. There are genera which have but one part; and suppose a species to be discovered with two, the case might happen that what was called calyx was really corolla. It is best, therefore, to call that part calyx which is nearly of equal length with the stamina, and is of a green and firm substance. These three circumstances must appear when we call the part a calyx. That should be called corolla which is longer or as long as the stamina, is coloured, and of a tender substance. Particular exceptions are not to be regarded. These three characters must always concur. For instance, the flowers of Thesium *linophyllum* have but one cover, which is somewhat longer than the stamina, of a firm substance, green, but white on the inner surface. This cover must be called calyx, because it is green on the outside, and of a firm substance. In like manner in Daphne *Mezereum* there is but one part, which is coloured, much longer than the stamina but of a firm substance. There are some allied genera that have yet a smaller calyx; even some species of Daphne that have something like a calyx; and therefore this part in the Mezereum must be called a corolla. But besides the three characters given above, we ought to attend to the affinity with other plants, and we will seldom err.

§ 157.

In constructing new genera, it is necessary, *that the essential character be applicable to all the species of the genus, and be subject to no variation.*

As the flower and fruit of one species are formed, so must those of all the rest be. For example, the fruit of one cannot be a berry and of another a drupa, though Linné has committed this mistake in the genus Rhamnus, which properly makes two distinct genera, namely, Rhamnus and Zizyphus.

§ 158.

The character of a genus must be formed from the number, figure, situation and proportion, (§ 157), *of the flower and fruit.*

It is only these circumstances, taken together, that constitute genera; taken separately, they are of no consequence. There are often species, which deviate from the generic character in this or that particular; but on that account they are not to be considered as distinct genera.

§ 159.

Number alone can never constitute genera, and must never be considered as of any importance.

Nothing is more subject to variation than the number of the stamina. They are often very various in the same genus. Some plants, when they grow in a rich soil, acquire one or two additional stamina and even additional petals. Often they are found with double the number of stamina they ought to have; for instance, a plant has ten stamina that should only have five; or contrariwise, it has only five stamina when it should have ten. Two often vary into four, three into six, four into eight, five into ten, six into twelve; in this way the number is either increased or diminished. When the structure of the other parts perfectly corresponds with another genus, and differs only in the number of a part of the flower, whether it be calyx, corolla, stamina or style, it would be improper on that account to make it a new genus.

§ 160.

When the number in all the parts of a flower is constant, it may be used as a subordinate generic character, but with great caution.

This rule must be used with great prudence. If it can be avoided, number must not be resorted to. Linné has given one example of this rule in the genera of Potentilla and Tormentilla. Number distinguishes these two artificial genera: the first has a double pentaphyllous calyx and a pentapetalous corolla. The calyx and corolla indeed remain constant in their number in both genera; but this example ought not to be imitated.

§ 161.

The monophyllous and polyphyllous calyx may constitute genera; but not the number of the laciniæ or leaves. The same thing may be said of the corolla.

There are some families in which the calyx is of importance; but in these the number of the laciniæ or foliola is not taken into account. If two plants resemble one another, but the one has a monophyllous and the other a polyphyllous calyx, they must be considered as different genera. The reason of which is, that a monophyllous calyx never changes into a polypetalous one; but the number of the foliola of a polypetalous calyx, or the number of laciniæ in a monophyllous one may be subject to variation. The same rule applies to the corolla.

§ 162.

The number of the stamina must be ascertained by the greatest number of flowers; but if the flower first evolved differs in number of stamina from the rest, we must reckon by it.

The flowers of some plants are not always constant in the number of stamina; in this case we must be guided by the greater number; after, however, examining a considerable quantity of flowers. Sometimes indeed there appears a variety in the number of stamina, the first evolved flower having more than the rest. In this case we must reckon by the first flower, as it is in general the most perfect. In numbering the stamina it is likewise adviseable to consider its affinity with other plants. As examples we refer to Ruta, Monotropa, and Chrysosplenium.

§ 163.

Too many genera are not to be made.

This rule is one of the most important. Many genera are a manifest disadvantage to the science. Generic differences are not too nicely to be sought for. It is the first duty of a botanist to make the science as easy and attainable as possible; but by a too refined exhibition of generic distinctions he will do it more harm than good.

If we consider as essential every small variation in the structure of flower and fruit, the number of genera will be multiplied, and the difficulty of the science increased. To this fault those are most prone who have seen fewest plants. When they have seen more, they will discover the intermediate plants which unite the different genera, and thus be forced to join what they formerly separated. I shall only here specify the genus Fumaria, several species of which have a differently formed pericarpium, but which, by a judicious arrangement, all run into one another. Linnæus himself has sometimes distinguished too nicely; the difference he makes between Prunus and Amygdalus is improper; when examined strictly by the foregoing rule, these genera ought to be joined.

§ 164.

The external appearance, (habitus), *of all the species of a genus, must likewise be attended to, but no generic characters taken from it.*

This rule is to be taken with many restrictions, lest by too rigid an adherence to it the science may be injured. In new genera we must take care that the habit does not agree with that of other genera; for it often happens that a plant, supposed to belong to a new genus, belongs to one already known, and varies only in the number or figure of the parts of the flower.

When a plant agrees in flower and fruit with those of a genus already established, but is of a very different habit, it must not on that account be separated. An example will illustrate this: suppose a person to discover a plant, which in flower and fruit was a perfect Tilia, but had an herbaceous stem and pinnated leaves: however much the habit might differ from that of the other species of Tilia, the plant onght to be referred to that genus. This example is not really found in nature, but similar ones are frequent. To exemplify the rule I shall however take a real instance from the same genus. There is a tree in North America whose fruit agrees with that of our Tilia, but in the flower there appear, besides the petals, small petal-like scales; the habit, however perfectly agrees with that of the lime-tree; and as the flower differs only in that inconsiderable circumstance, the plant is properly referred to the genus Tilia.

§ 165.

The regularity of the flower is no certain generic character.

The relative length of the petals is not always constant, and therefore affords no proper generic distinction. Suppose plants were discovered that differed only from one another in the irregularity of the flower, how undetermined would the science of Botany become, if the genera were to be multiplied from so trivial a circumstance!

§ 166.

The figure of the flower is always to be taken in preference to that of the fruit.

There are more genera, whose species agree in the flower, than there are whose species agree in the form of the fruit. The older botanists were too attentive to the fruit, which when it only differs in external figure is of little importance. In the genus Pinus we have an apt example. Formerly several genera were made of it, according as the fruit was round, or long, or pointed, or obtuse, &c. The number of the cells in a pericarp has likewise misled some botanists; but these alone can never be a discriminating circumstance; as number (§ 159) never affords generic characters.

§ 167.

Slight variations in the figure of the flower are of no consequence in establishing genera.

The form of the corolla is very various, as we know from the Terminology: but there are many kinds of it that very nearly resemble one another. This great resemblance shews evidently that the transition from one to another is but small, and that nature does not guide herself according to our distinctions. A funnel-shaped corolla easily passes into a salver-shaped one, and *vice versa;* if genera were to be formed upon such small circumstances, the number would become too great. In the genus Convallaria, the species Solomon's seal, (C. *Polygonatum*), has a tubular, the lily of the valley, (C. *majalis*), a bell-shaped corolla. Hence we see that these trivial variations of allied species of corolla are of little consequence. But when plants with monopetalous and polypetalous flowers are allied, they must form separate genera. The form of the corolla must be very different when it gives occasion to form new genera.

§ 168.

When the fruit in allied plants is very different, the genera must be separated.

Plants may agree perfectly in their flowers while they bear very different fruit. If the variety in the fruit does not rest on the number of the cells or of the seeds, or on the form of these alone, the plants must form distinct genera. The example already brought from the genus Rhamnus, (§ 157), affords a proof of this. The genera Abroma and Theobroma differ only in the fruit. Such distinctions are very beautiful, and ought never to be overlooked.

§ 169.

The Nectarium affords the best generic character.

When the nectarium, on account of its singular figure, distinguishes one flower from another, it is an excellent character. But it must be remarked, that the structure of the nectary must be striking: for it would be improper to consider the Arenaria *peploides* as a distinct genus, because there are glands in the flower; or to separate the American Tilia, (§ 164), from the European, because there are small scales in the corolla. But if, as in other plants, there are nectaria of a cylindrical or filiform figure, such a singular structure ought not to be overlooked. The rule is not of difficult observation, for there are but few exceptions to it.

§ 170.

The figure of the style and of the filaments affords no generic character, except it is very remarkable.

It often happens, that the figure of the style and of the filaments in some species of a genus is very different; that the style and filaments are bent down, or are otherwise of a peculiar figure; but this, in general, is of little importance. However, if in any genus there is an essential difference in these parts, as in Cordia, it deserves particular attention.

The germen may be supported on a stalk within the flower, as in Euphorbia, Passiflora, Helicteris, Sterculia, &c. which is a striking character not to be neglected. Linné was induced by this stalk, which is nothing more than an elongation of the receptacle, to consider it as another style below the germen; and he accordingly reduces various genera of this kind to his class Gynandria, (§ 142).

§ 171.

The situation of the germen is an excellent generic character.

However similarly constructed plants may be, if the germen in one is above and in another is below the calyx, they must form separate genera. There is no instance known where this situation of the germen is subject to variation. A single exception is found in the genus Saxifraga; where in some species the germen is under the calyx; in some it is half above and half below, and in others it is wholly above the calyx. But here we see the transition distinctly, and consequently this instance alone is an exception to the rule.

§ 172.

The situation or rather the insertion of the stamina is of great importance in a generic character.

Whether the stamina are inserted in the calyx, in the corolla, or in the receptacle, they afford a principal character in establishing genera. Let the conformity of the whole plant or flower be what it may, the genera must be determined by the insertion of the stamina. In the caryophyllous plants, particularly in Lychnis and Silene, some filaments are inserted in the receptacle, and some in the corolla: these accordingly make one exception to the rule.

§ 173.

The sex, (sexus), *of plants, can never serve as a discriminating character of a genus.*

If a plant differs from another in sex, this circumstance is not to be taken into the generic character; at least it cannot serve any important purpose. We have already remarked, that no character is more unsteady than that of sex; for hermaphrodite flowers are often by culture changed into male and female flowers, and even difference of climate produces the same effect. For instance, in our garden, the Ceratonia *siliqua* is constantly observed with perfect flowers, of different sexes on different trees, (Dioecia), though in Egypt it is constantly found with hermaphrodite flowers. Many genera, as Lychnis, Valeriana, Cucubalus, Urtica, Carex, &c. have species with hermaphrodite flowers, though all the rest are dioicous.

Flowers that are of neither sex, (*flores neutri*), having neither stamina nor style, and which are found between fertile flowers, as in Viburnum and Hydrangea, cannot serve as generic marks. The plants of the 19th class form the only exception.

Hitherto we have only stated the rules that are generally applicable, to all the families of the vegetable kingdom. There are, however, particular rules for single plants that we must here take notice of. Whoever attends to them and to the rules already laid down, will find no difficulty in characterizing genera. Particular rules might be given for all the natural families, but it is sufficient to specify the most important.

§ 174.

The Grasses, (§ 122, No. 5), have too great a similarity in their whole structure not to make it necessary to select particular rules for ascertaining the genera. The number of the stamina, the presence or want of an arista, can by no means serve either for separating or for establishing genera. The number of the flowers, of the valves, and of the style, however, should not be neglected: there is hardly any thing else that affords better distinguishing marks than these; and, being steady, if they were to be overlooked the genera would grow too large. The Involucrum, which is found in some grasses, affords various characters that ought not to be rejected, as does likewise the form of the valves and nectaria.

§ 175.

The Lilies, (§ 122, No. 6), must be distinguished by the spatha, according as it is one or many-leaved, one or many-flowered: and also, which happens in few other plants, the stigma, the duration of the corolla, and the direction of the stamina serve for distinguishing genera. We must likewise observe whether the stigma be divided, and how often; whether the corolla falls off, grows dry, or is persistent; lastly, whether the stamina are erect or bent down; or take an oblique direction. In this, as well as in the other natural families, the general rules already laid down are at the same time to be observed.

§ 176.

The umbelliferous plants, (§ 143, No. 45), have, of all the natural families, the greatest resemblance to one another. They are all furnished with a pentapetalous corolla, five stamina, an inferior germen, two pistilla; and even the mode of florescence and the fruit, which consists of two naked seeds, are similar. Linnæus imagined he had found a discriminating circumstance in the general and partial involucrum, (§ 36), by which the genera were to be ascertained: but this part is subject to great variation, and can in very few cases afford a good character. Another difference has been found in the fruit. Though this always consists of two naked seeds, yet their figure is remarkably different; and upon this alone are founded the generic characters in the natural order of Umbelliferæ.

§ 177.

In the labiated and ringent flowers, or the whole fourteenth class of the Linnæan System, (§ 139). the genera are established on the corolla, the calyx, and the direction of the stamina. In the first order, (§ 140), the fruit, which in the whole is similarly formed, affords no character, any more than the style, for in most the fruit consists of four naked seeds; the pistillum consists of a simple style and a bifid stigma. It is the laciniæ of the calyx, the variously formed lips of the corolla, and, in a few genera, the direction of the stamina, which in most lie in the upper lip, that afford characters in this family. In the second order, (§ 140), the fruit, which is still more different, affords a number of characters for distinguishing genera. It is remarkable in this family, that some of the plants want a lip; those in the first order wanting the upper, and those in the last the under lip. Teucrium and Ajuga may serve as examples of the first order; Tourettia and Castilleja of the second. The Scordium of Cavanilles, which has an upper but no under lip, is an exception, as it belongs to the first order.

§ 178.

The cruciform flowers, or the plants belonging to the fifteenth class, (§ 139), on account of the great similarity of their parts, are with the greatest difficulty distributed into genera. It is the fruit alone which can distinguish them, and sometimes the nectaria in the flower; the calyx very seldom, and according as it stands out or is close applied. The corolla may likewise afford a distinguishing character, but is in all similarly formed, and the single genus Iberis appears with two petals shorter than the rest.

§ 179.

The Papilionaceæ, or those of the 17th class, (§ 139), are likewise very similar both in flower and fruit. The calyx is in them the most important part. The characters from the corolla are less decisive;

cisive; for they depend on the proportion of its particular parts, or on their situation. Such characters are not to be recommended, except where no better can be had, or when the situation and proportion are very remarkable. The connate stamina are of little importance, but the stigma makes a very proper distinctive mark. Whether the fruit in most of these plants be a legumen or a lomentum, it differs very much in figure: and according to the figure, cloathing, or number of the seeds it contains, may the genera be determined.

§ 180.

The compound flowers, or the 19th class, (§ 139), on account of their peculiar structure are subject to very different rules. In these attention must be paid to the common perianth, the receptacle, and the pappus. On these are founded the genera of this whole family. The sex, which Linnæus employs in the orders of this class, (§ 140), cannot be approved of in distinguishing the genera, and still less the form of the flower. Many genera of this class that have no radius, nevertheless acquire it in favourable situations or in warm regions, and others in like manner lose it. A common plant with us, the Bidens *cernua*, according to the generic character should have no radius; but when it is found in very wet slimy ground, it grows radiate. Linné, who had seen both varieties, took the radiate plant for a particular genus, and called it Coreopsis *Bidens*. Hence it follows, that the genera Coreopsis and Bidens are not different, except their separation should depend on the trivial circumstance abovementioned. We might here bring forward several other examples, but they will easily be found upon attentive investigation.

§ 181.

The Cryptogamiæ, (§ 139), or the plants of the 24th class, whose flowers are not obvious to the unassisted eye, must be determined by their fruit. No character of these plants should be taken that requires a magnifier, and the character taken should be easily found. The flower of the cryptogamious plants is of such a kind that it can be seen only at a certain time, often for a very short period, and with a high magnifier: in some it has not yet been discovered at all. It would, therefore, be a very great error to select for a generic character a part not easily visible, and found with great difficulty. But the fruit is very easily seen, and may be examined with a moderate magnifier; so that it alone must give the character. We have not yet, however, sufficiently investigated the fruit in all the species of Cryptogamiæ: there are consequently several gaps in this class which remain to be filled up.

In the Filices, Linnæus has assumed the mode of inflorescence as the generic mark. In some of these the fruit stands in rows, in others in circles; sometimes in the centre, sometimes in the margin or in the angles of the leaves. In other plants this circumstance is of no use, but in the Filices we are obliged to resort to it.

The character which Dr Smith has chosen for discriminating the genera in the Filices is the Indusium, (§ 40. 122). As this character is easily seen, he observes how it separates, and in what order the seed-capsules under it are placed. In other Filices, that have not their fructification on the back of the leaf, we must resort to the figure of the fruit.

The Musci frondosi, (§ 122), have of late been very accurately investigated, and their flowers and fruit are known: we are therefore now able to distinguish their genera better than formerly, the characters of which are taken from the peristoma, (§ 111. d). This organ affords a number of characters, that are steady and easily seen.

The Musci hepatici, (§ 122), are also arranged in genera by the fruit, according to the mode in which it opens.

The Algæ, (§ 122), have their genera ascertained according to the form of the fruit, so far as this is known; but the external form must not be employed for this purpose.

The same characters are used in the Fungi, (122), but these are so numerous, and their duration is so short, that the industry of many naturalists in different places will be required to fill up the blanks in this order.

It remains to be observed further, that all genera must be determined by the flower and fruit, and never by the root, the stem, or other parts, not even by the involucrum.

§ 182.

§ 182.

A SPECIES means each particular plant standing under a genus, which continues unchanged when raised from seed. A VARIETY, (*varietas*), is a plant differing in colour, figure, size or smell from a known species, which easily by seed returns to the particular species it arose from. Species that require great attention to be distinguished from one another, but which constantly remain the same when raised from seed, are easily mistaken for varieties; and on account of the great resemblance they have to one another some botanists give them the name of SUBSPECIES. But all these may be determined by the simple division into Species and Varieties, and as this division is easily understood, it seems superfluous to descend to Subspecies. Varieties must not be confounded with monsters, (MONSTRA); these are, it is true, varieties, with this difference that they are not continued by seed. Diseased plants have likewise sometimes the appearance of varieties; but they are easily distinguished, as we shall see hereafter. The various rules, according to which species are to be ascertained, are not founded on the flower or fruit, but upon other parts of the plant.

§ 183.

In distinguishing species regard is not to be had to colour, smell, taste, size, or to the external surface, viz. *whether it be smooth or hairy.*

When two plants differ from one another only in the colour of the flower, in having a different smell or taste, in one being a foot, and the other a cubit high; or in the one having a smooth and the other a hairy leaf or stem; such plants can be considered merely as varieties. If one plant differs from another in all these qualities together, it may pass for a different species.

White or black spots on the leaves of the plant cannot discriminate species, and should only be taken into account when plants really different cannot be distinguished otherwise. But if a species can be ascertained without having recourse to colour, it is always better.

Smell and taste, as they are only comparative qualities, cannot be received as specific characters.

The size depends so much on the quality of the soil that no regard can be had to it. The pubescence is exactly in the same circumstances; for a hairy leaf will become smooth in a different soil.

Plants with tomentose, spiny or woolly leaves or stalks, are not so easily considered as Varieties, and these qualities afford the best distinctions.

§ 184.

The root gives a beautiful and infallible mark for distinguishing species.

When the root in two similar plants is different, they may be considered as different species. Cultivated plants are indeed an exception. Culture for a length of time, or the skill of a gardener, often give plants a very different appearance, as in the carrot, (Daucus *carota*). In its wild state this plant has no large or yellow roots; it receives these solely from culture. But the above rule is applicable solely to wild plants; however, if we can avoid drawing the specific character from the root, and can take it from other marks, it is so much the better, as we have not always an opportunity of examining the root, particularly in a hortus siccus.

§ 185.

The stem affords a certain and obvious specific distinction.

The stem seldom varies, and therefore gives an excellent character; in particular the round, the cornered, the jointed, the creeping, &c. stems, are very steady. The branched stem is not so sure a mark; it is very subject to variation, and therefore gives no certain character.

§ 186.

The duration of a plant is a proper distinguishing mark of the species only in its native situation.

When allied or very similar plants differ in duration, so that one is an annual, the other a shrubby plant, or even tree, they must be considered as different species. But the duration of these, in the places where they grow wild, must be investigated. All plants that are biennial with us are annual in warmer climates. Some that are perennial in warm countries turn annual with us: the root is killed in our winters, and it must be restored by sowing it again. Other perennial plants with us are shrubs in warm countries, because no cold destroys their stems. When thus the duration of a plant exhibits any discriminating mark, the other species must be accurately examined to know whether they too are not of longer duration in a milder climate. But if plants vary in this respect in the same region, such must be considered as different species; for example, the Mercurialis *annua* and *perennis* resemble one another much, but the names express a distinct specific difference.

§ 187.

Most plants are distinguished from one another by their leaves.

Almost all plants are distinguished by the various form of their leaves. But there are instances where this character will not answer; for the umbelliferous, the compound, all the aquatic plants, figs, and mulberries are an exception. In these the leaves are subject to such considerable variations, that without much experience it is difficult to distinguish a species from a variety. When, therefore, there is uncertainty in the leaves, other characters must be resorted to.

When plants differ from one another by their spines, stipulæ or bracteæ, they may be considered as distinct species. But it is to be observed, that these parts, if taken as specific characters, must not be subject to fall off.

§ 188.

The props, (fulcra), *present certain specific characters, which are to be preferred to all others.*

When plants differ from one another by their spines, stipulæ or bracteæ, they may be considered as distinct species. But it is to be observed, that these parts, if taken as specific characters, must not be subject to fall off.

§ 189.

The thorn, (spina), *and the tendril,* (cirrhus), *are always to be taken as certain characters.*

The thorn is nothing more than an indurated imperfect bud, which, when the plant grows in a luxuriant soil, changes to a branch. Pears, oranges, and other plants in a poor soil produce thorns, which leave them in richer ground. Some plants that have many thorns, retain them even in fertile soils. The prickle is very constant, and is never altered by change of soil. In the same manner the tendril changes in some plants with papilionaceous flowers. We must first be perfectly certain that the thorn or the tendril are never wanting before we distinguish the species by them.

§ 190.

The mode of inflorescence is a certain character.

We have no instances of the mode of inflorescence being subject to variation. When plants differ in this respect they are undoubtedly different species. The number of the flowers, that is, whether they

be

be two, three or more, is an uncertain character. In general it may be observed, that nothing is so inconstant as number, and that it ought never to be founded on.

§ 191.

A species is never to be made a variety, nor a variety a species, on account of any small difference.

We shall see by the history of our science, that in the 17th and in the beginning of the 18th century, every inconsiderable variety of a plant was made a species, which led to great error. It is a rule, rather to take a plant for a variety than to make it too easily a species.

§ 192.

The selected characters of a species must be conspicuous, in the varieties.

If a plant is subject to great changes, the characters must be so chosen that they may be seen in all its varieties. It would, therefore, be faulty to separate a plant that commonly has a five-lobed leaf, and varies with an intire leaf, from another plant, merely on account of its five-lobed leaf. In this case we must seek for other characters, otherwise the beginner, who has seen nothing but the variety, will never come to the knowledge of the species.

§ 193.

The characters, by which all the species of a genus are distinguished, must be taken from one or a few parts.

In a genus which has many species, if I should characterize the first by the spike, the second by the leaves, the third by the stem, the fourth by the root, the fifth by the fruit, &c. no person with certainty would know the plants.

It is necessary to observe in the species of a genus, what parts afford the best characters, and if there are many, they must be pointed out, and the differences remarked, that there may be no uncertainty or mistake.

§ 194.

It is only at the time of flowering, or of ripening the fruit that characters should be taken.

No botanist can with certainty distinguish plants without flowers or fruit, otherwise he must by frequent practice have attained a facility in distinguishing them by their leaves. Thus characters afforded by plants before the developement of the flower or the ripening of the fruit are of no use.

§ 195.

The other characters by which species are ascertained must be learned by experience. It is further however to be remarked, that a description is to be made according to the rules of accurate terminology, in the following order; first the root, then the stem, the leaves, the fulcra, and lastly, the inflorescence. In a description, the colour of the flower is likewise to be mentioned, but superfluous or unimportant circumstances are to be omitted; such as that the root is under ground, that the leaves are green, &c. The old botanists frequently err in this respect.

§ 196.

The essential difference, or name, (*diagnosis*), of the species is a short description containing only what is essential; according to the following rules.

The specific name must not be too long, and if possible should be contained in twelve words.

We have seen, (§ 193), that in forming the specific name we must express only the essential difference, and so characterise it, that he who sees the plant for the first time, though he has never seen the other species of the genus, may be at no loss to know what plant he has before him. Words that are superfluous, must be omitted, and only those made use of which distinguish the plant from all others. If more than twelve words are necessary for the complete denomination of the plant, they must be adopted: for it is better that the name be long and distinct, than short and unintelligible.

The specific name must be in the Latin language, and all the words in the ablative case.

We shall here recur to our old example, the Solanum *tuberosum*, the difference between which and the other numerous species of the genus is expressed as follows.

Solanum *tuberosum;* caule inermi herbaceo, foliis pinnatis integerrimis, pedunculis subdivisis.

In the specific name there must be no relative idea.

What was formerly said with regard to the distinguishing of the species is applicable here. Magnitude,

nitude, colour, &c. are not to be made use of, because these things can only be understood by comparison with other plants, and we have not always at hand the object of comparison. The following, which errs against this rule, may serve as an example.

Solanum arborescens, tomentosum, latifolium; fructu magno cinereo. Barr. aequin. 104.

Who can know from this character what plant is meant?

There must be no negative expression in the specific name.

When in a specific name it is only said what the plant has not, it is evident that nothing certain can be learned from it, *e. g.*

Cuscuta caule parasitico, volubili, lupuliformi, aspero punctato, floribus racemosis, non conglomeratis aut pedunculatis. Krock Siles. 251.

When a genus consists but of one species, there is no occasion for a specific difference.

It is evident that a single species, that cannot be compared with another, can have no discriminating character. Thus it is, in particular, with Butomus, Paris, Parnassia, &c.

But when only one species of a genus is discovered, an accurate description must be made of it, that it may be distinguished if others should be discovered.

§ 197.

The complete description of the natural characters, (§ 148), of a genus, must be made in the following order: First, the calyx, then the corolla, the nectarium, the stamina, the pistillum, the fruit and the seed. In the compound flowers we end with the receptacle, and in the umbelliferæ we begin with the involucrum. A full description of the genus is contained in the essential character, the rules for forming which have been already detailed.

§ 198.

Varieties, if they are not remarkable, deserve little attention from botanists: but if they are of a very singular figure, they must be taken notice of and described, that they may not be considered as species. Variations in colour only are of no consequence, being exceedingly subject to change, as we shall see immediately, (§ 201).

§ 199.

In plants the following are the principal colours:

1. *Cyaneus*, dark blue, like Prussian blue.

2. *Coeruleus*, sky blue, like the flowers of Veronica *chamædrys*.

3. *Azureus*, azure blue, nearly the same with the former, but bright, like ultramarine.

4. *Caesius*, pale blue, verging towards grey.

5. *Atrovirens*, dark green, bordering on dark blue.

6. *Aeruginosus*, light bluish green, like verdigrease.

7. *Prasinus*, *saturate-virens*, *smaragdinus*, grass-green, without any tinge of yellow or blue.

8. *Flavo-virens*, green, verging upon yellow.

9. *Glaucus*, green, bordering upon grey.

10. *Aureus*, gold-yellow, without any foreign mixture.

11. *Ochraceus*, yellow, with a small tinge of brown.

12. *Pallide-flavens*, pale or whitish yellow.

13. *Sulphureus*, bright yellow, like the flowers of the Hieracium *Pilosella*.

14. *Vitellinus*, yellow, with a slight tinge of red.

15. *Ferrugineus*, brown, verging towards yellow.

16. *Brunneus*, the darkest pure brown.

17. *Fuscus*, brown, running into grey.

18. *Badius*, *hepaticus*, chesnut or liver brown, bordering on dark red.

19. *Aurantiacus*, orange, or a mixture of yellow and red.

20. *Miniatus*, s. *cinnabarinus*, high red, like red-lead.

21. *Lateritius*, brick-colour, like the former, but duller, and verging towards yellow.

22. *Coccineus*, s. *phoeniceus*, cinnabar colour, with a slight tinge of blue.

23. *Carneus*, flesh-colour, something between white and red.

24. *Croceus*, saffron colour, dark orange.

25. *Puniceus*, fine bright red, like carmine.

26. *Sanguineus*, s. *purpureus*, pure red, but duller than the foregoing.

27. *Roseus*, rose colour, a pale blood-red.

28. *Atropurpureus*, very dark red, almost approaching to black.

29. *Violaceus*, violet colour, a mixture of blue and red.

30. *Lilacinus*, lilac, the former colour, but duller, and verging more towards red.

31. *Ater*, the purest and deepest black.

32. *Niger*, black, with a tinge of grey.

33. *Cinereus*, ash-colour, blackish grey.

34. *Griseus*, lively light grey.

35. *Canus*, hoary, with more white than grey.

36. *Lividus*, dark grey, running into violet.

37. *Lacteus*, s. *candidus*, shining white.

38. *Albus*, dull white.

39. *Albidus*, dirty dull white.

40. *Hyalinus*, transparent like pure glass.

These colours are only used in describing the Lichens and Fungi: being not so variable in these plants as in others.

The colours are all represented on the 10th plate, for mere words do not convey a sufficient idea of them.

§ 200.

In general every part of a plant has a particular colour.

The root is for the most part black or white, sometimes brown, seldom yellow or red, but never green.

The stem and the leaves are commonly green, seldom red, sometimes spotted with white or black, very seldom yellow, externally seldom blue, and only white or brown when covered with a tomentum.

The corolla is of every different colour, but seldom green, and still seldomer black: the calyx is generally green, seldom of any other colour, never black.

The filaments are commonly transparent or white, seldom of other colours.

The succulent kinds of fruit are of all colours.

The capsules are brown, green or red, seldom black.

The seed is black or brown, seldom of other colours.

N. It is remarkable, that the yellow colour predominates in the compound flowers and in most autumnal flowers. White is found chiefly in the spring flowers; white and blue principally in the flowers of cold regions; red and richly variegated colours in those of warm climates. White berries are commonly sweet; red, sour; blue, sweet and sour mixed; and black, insipid or poisonous.

§ 201.

Though the botanist seldom trusts much to colour; yet it is of use to know in what way flowers and fruits sometimes change from one colour to another.

In general most colours pass into white; the red and the blue are most prone to change. It is not often that the change is made into yellow, or that red passes into yellow: blue very often turns to red. We shall here give a few examples:

Red passes into white in

Erica, Serpyllum, Betonica, Pedicularis, Dianthus, Agrostemma, Trifolium, Orchis, Digitalis, Carduus, Serratula, Papaver, Fumaria, Geranium, and many others.

Blue changes into white in

Campanula, Pulmonaria, Anemone, Aquilegia, Viola, Vicia, Galega, Polygala, Symphytum, Borago, Hyssopus, Dracocephalum, Scabiosa, Jasione, Centaurea, and many others.

Yellow changes into white in

Melilotus, Agrimonia, Verbascum, Tulipa, Alcea, Centaurea, Chrysanthemum, &c.

Blue changes into red in

Aquilegia, Polygala, Anemone, Centaurea, Pulmonaria, &c.

Blue changes into yellow in

Commelina, Crocus, &c.

Red changes into yellow in

Mirabilis, Tulipa, Anthyllis, &c.

Red changes into blue in

Anagallis, &c.

White into red in

Oxalis, Datura, Pisum, Bellis.

Fruits, particularly the juicy kinds, often change their colours.

Black berries change into white in

Rubus, Myrtillus, Sambucus, &c.

Black into yellow in

Solanum.

Red passes into white in

Ribes, Rubus *Idæus.*

Red into yellow in

Cornus.

Green into red in
Ribes *Grossularia.*
Black into green in
Sambucus.

The seeds of plants likewise frequently change from one colour to another; the poppy, (*Papaver*), has both black and white seeds.

The seeds of papilionaceous flowers are most subject to vary in colour.

§ 202.

The leaves are in some plants naturally spotted; but the spots are not always constant; they frequently disappear altogether. Of this we have examples in the following:

Leaves with black spots.
Arum, Polygonum, Orchis, Hieracium, Hypochaeris.
Leaves with white spots.
Pulmonaria, Cyclamen.
Leaves with red spots.
Lactuca, Rumex, Beta, Amaranthus.
Leaves with yellow spots.
Amaranthus.

The leaves of some plants become red in autumn, as those of Rumex: others at times produce leaves wholly red, as Angelica, Fagus, Beta, Amaranthus. Most plants change into yellowish green, light green or dark green from excess of heat, or of cold, from defect in the structure of the vessels, or from variety of soil and situation. From similar circumstances, the margin or centre of a leaf is subject to change. Gardeners are fond of such plants, which they call *blotched*. When the margin is yellow, the leaves are called *folia aurata;* when the centre has a yellow spot, they are called *folia aureo-variegata;* when the leaf is white on the margin, it is called *folium argenteo*, s. *albo-marginatum;* when it is white in the centre, it is called *folium albo*, s. *argenteo-variegatum*.

§ 203.

Besides in colour, leaves change also in number, breadth, figure and parts. In number leaves change only when they are compound or opposite. They vary often in breadth, so that an oval leaf frequently becomes oblong, &c. Culture often changes the figure of leaves, especially in rich soils. Of this we have an example in the common colewort; and other plants acquire sometimes waved or crisped leaves.

The different divisions of leaves often change remarkably the appearance of a plant. The common elder, (Sambucus *nigra*), has sometimes finely cut leaves. The alder, (Betula *alnus*), has likewise lobed or divided leaves; and many others are subject to like varieties. Culture is the true touchstone of plants; by frequent sowing the seeds we can determine with certainty what are varieties, and what are species. This is the only means of arriving at the truth.

§ 204.

When the student has become acquainted with these rules, and by practice has attained a readiness in employing them, he will yet find difficulty in determining plants he has never seen before. In this case the following directions are to be observed:

In the first place he is accurately to examine the flower, and endeavour to refer it to its class and order, by attending to the number, proportion, and connexion of the parts of the fructification. When he has succeeded in this, he seeks out the genus in his system. Here, however, he may encounter some difficulties, which he must carefully endeavour to overcome.

The stamina, and likewise the pistillum, often vary according to the soil and climate in which the plant has grown, so that sometimes there is a stamen more or less than there should be: in this case he must examine many flowers, and be ruled by the majority. There is often likewise a luxuriance in plants, which doubles the number of parts; and often a defect, when a half is wanting: thus sometimes there are eight instead of four stamina, and sometimes only two. When in this case he cannot find the plant in the class where he thinks it ought to be, he must try the other classes where it may be. Sometimes the antheræ and filaments are united, which is not the case in other species, and the sex also is subject to variation. Therefore, when a plant is not found in the class to which it seems to belong, he must search the 21st, 22d and 23d classes. If he is convinced after these searches that the plant is new, he must describe it as such. Dr Roth and Professor Hedwig have done an essential service to botany by making an index of the most frequent variations in the number and sex of different plants.

When one has been fortunate enough to discover the genus of an unknown plant he must proceed to determine its species. He must compare the specific characters, and never consider any plant as determined till he finds it agree with those laid down. When these characters are not sufficient, he then compares it with the synonyma, to see if from them he can discover it with certainty. In the references he makes to authors Linnæus has, after the page, added an asterisk (*) to those who have given a good description of the plant, by which the further investigation is very much assisted. But when the plant is obscure, or not certainly known, he distinguishes it by a cross, (†).

The duration of a plant he has marked after the place in which it is a native. If it be a tree or a shrub, he marks it with this character, ♄; if a perennial with this, ♃; if a biennial thus, ♂, and if an annual thus, ⊙.

IV. NOMENCLATURE OF PLANTS.

§ 205.

It appears to be of little importance to give a plant a new name; but it is certainly agreeable to one who makes botany his study, to find a name that is appropriate, and easily and generally received. When the name is indeterminate and unsettled, the knowledge of the thing is lost. The old botanists were not much concerned about preserving the names of plants. Every one who turned author gave them new ones, and thus in those times the study of Botany was unpleasant and uncertain. Persons were disgusted with the barbarous, dry and unfixed nomenclature which prevailed, and declined entering on the study of the most beautiful objects of nature, on account of the difficulty and uncertainty which attended it. But by the introduction of fixed and generally received names, we are now able to make ourselves understood wherever Botany is known.

§ 206.

Tournefort, who undertook to reform the science of Botany, established genera, and invented names for them: but the species were still distinguished by short and often imperfect descriptions. The generic name was then, it is true, better defined, but the species were left still undetermined. In this, as in every other department of the science of Botany, Linnæus has performed the most eminent service by establishing a generic name, (*nomen genericum*), and a trivial name, (*nomen triviale*), to every plant. The rule by which these names are imposed is as follows:

§ 207.

Each genus must be defined and properly denominated; and every new genus must likewise have a new name. A name once properly imposed, is not afterwards to be changed. None but a botanist, who is acquainted with the names of all other plants, has a right to impose a name, lest the same genus should receive two different names.

§ 208.

Generally received names must be preserved; and when new discovered plants receive two names from different botanists, the first that was imposed, if it is a good one, must be adopted.

As most botanists now follow Linnæus, it is their duty to preserve his names when they are applied to true genera. In newly discovered plants, it often happens that two botanists, in different places, about the same time, give each a name to the genus. One only of these can belong to it, and therefore that which was first imposed, if it is good, and formed according to rule, must be received. For instance, the bread-fruit tree was described by Solander, by Forster and by Thunberg. Solander called it *Sitodium*, Forster *Artocarpus*, and Thunberg *Rademachera*. Forster's name was the first and likewise the best, consequently it is that which is generally received.

§ 209.

Names must not be too long.

If the name of a genus is composed of many short words, it becomes too long and displeasing to the ear. Some of the names given by the older botanists may serve as examples, *viz.*

Calophyllodendron.
Cariotragematodendros.
Acrochordodendros.
Leuconarcissolirion.
Orbitochortus.
Hypophyllocarpodendron.
Stachyarpogophora.
Myrobatindum.

§ 210.

Names must not be taken from foreign languages, nor even from the European; but, when it can be done, they should be formed from the Greek.

Names taken from foreign languages, even though they have a Latin termination, are improper, and cannot be so classically compounded as the Greek. Even names formed from the Latin are destitute of euphony, and still more so when they are compounded

pounded of Latin and Greek together. When it is possible they should be made out of two Greek words with a Latin termination. The following are examples of faulty names:

Out of the American languages.

Aberemoa. Apeiba. Apalatoa.
Bocoa. Caraipa. Cassipourea.
Conceveiba. Caumarouna. Faramea.
Guapira. Heymassoli. Icacorea.
Metayba. Ocotea. Pachira.
Paypayrola. Quaypoya. Saouari.
Tocoyena. Vouacapoua. Vatoirea.

From the Malabar language.

Manjapumeram. Balam-pulli.
Cudu-Pariti. Cumbulu.

From the Latin language.

Corona solis. Crista galli. Dens leonis.
Tuberosa. Graminifolia. Odorata.

From the German language.

Bovista. Beccabunga. Brunella.

From other European languages.

Belladonna, Sarsaparilla, Galega, Orvala, Amberboi, Percepier, Crupina.

From Greek and Latin together.

*Lin*agrostis, *Cardam*indum *Chrysanthem*indum, *Sap*indus.

Such names are always faulty; and though some of them have been received, they ought never to be imitated.

The following names are better:

Glycirrhiza, from γλυκὺς sweet, and ῥίζα a root.

Liriodendron from λεὶριον a lily, and δένδρον a tree.
Ophioxylon — ὂφις a serpent, and ξυλον wood.
Cephalanthus — κεφαλὴ the head, and ἀιθος a flower.
Lithospermum — λίθος a stone, and σπὲρμα seed.
Leontodon — λέων a lion, and υδȣς a tooth.
Hippuris — ἵππος a horse, and ȣ̓ρα a tail.

§ 211.

Plants must not be denominated by names already appropriated to animals or fossils.

The names of plants must not be the same with those of any animals or minerals; but each genus in all the three kingdoms of nature ought to have different names. The following are faulty in this respect.

Taxus, Onagra, Elephas, Ampelis, Natrix, Delphinium, Ephemerum, Eruca, Locusta, Phalangium, Staphylinus, Granatum, Hyacinthus, Plumbago.

§ 212.

Names must not be received that are borrowed from religious, divine, moral, anatomical, pathological, geographical, or other terms.

When we choose a name having a reference to religious or other matters, with which it cannot properly be compared, or which are not known to every one, it is good for nothing. The following names are therefore faulty.

Religious.

Pater noster.
Morsus Diaboli.
Fuga Dæmonum.
Oculus Christi.
Spina Christi.
Palma Christi.

Calceus Mariæ. Labrum Veneris,
Barba Jovis. Umbilicus Veneris.

Poetical.

Ambrosia. Cornucopiæ. Protea.
Narcissus. Adonis. Andromeda.
Gramen Parnassi, &c.

Moral.

Impatiens. Patientia. Concordia.

Anatomical.

Clitoris, Vulvaria, Priapus, Umbilicus.

Pathological.

Paralysis. Sphacelus. Verruca.

Oeconomical.

Candela, Ferrum equinum, Serra, Bursa pastoris.

From the native place.

Hortensia, China, Molucca, Ternatea.

§ 213.

The names of genera must be framed according to resemblances or properties, which, however, must be found not in one species of the genus only, but in several.

When the name can be formed according to the essential character of the genus, to the figure of the seed, its resemblance to other plants, or to the form of the flower, such a name is to be preferred, because it conveys some idea of the plant. The properties of a plant, or its colour, do not afford good names, though sometimes recourse must be had to them: but when the names are taken from unsteady marks, such as the woolliness of the leaf or stem,

which

which is proper only to one species, they are to be rejected.

The following names are taken from a single part of a plant, and are not to be imitated.

Cyanella; on account of its blue flower; but there are species with white and yellow flowers.

Argophyllum; on account of its tomentose white leaves.

Gratiola; for its use in surgery.

Samolus; from the island of Samos, where it was first found.

§ 214.

Names ending in oides, astrum, astroides, ago, ella, ana, *must be carefully avoided.*

By these terminations the resemblances of plants to others are intended, at the same time implying a doubt. Those names of this kind are especially to be avoided, which are of a disagreeable or harsh sound; such as,

Alsinoides.
Alsinella.
Alsinastrum.
Alsinastroides.
Alsinastriformis.
Anagalloides.
Anagallastrum.
Lycoperdastrum.
Lycoperdoides.
Juncago.
Erucago.
Portulacaria.
Breyniana.
Ruyschiana.
Clathroidastrum.

§ 215.

Names similar in sound must likewise be avoided.

A name may sometimes be very proper, but may be faulty in having nearly the same sound with another, and ought therefore to be changed, that it may not be mistaken in printing or speaking: such as,

Conocarpus.	Ambrosia.	Gaura.
Gonocarpus.	Ambrosinia.	Guarea.

§ 216.

The name of a class or order can never be received as the name of a genus.

The antients often use the name of a whole family for a single genus. This leads beginners into error, and one sometimes knows not whether a class or a genus is meant. Thus we find Lilium, Palma, Muscus, Filix, Fungus, &c.

§ 217.

The highest reward of a botanist is to have a genus called after his name.

No monument of marble or brass is so lasting as this. It is the only way of perpetuating the memories of true botanists, or of those who have benefited the science.

The names of botanists must be preserved unchanged, only giving them a proper Latin termination; as,

Linnæa, Royenia, Thunbergia, Sparmannia, Gleditschia, Halleria, Buxbaumia, Smithia, &c.

§ 218.

For the better distinguishing of the species, Linné, besides the generic name, contrived a second, which he called the trivial name, (*nomen triviale*, § 220).

With

With regard to this the following things are to be observed.

§ 219.

A trivial name must be short, unlike to the generic name, and always an adjective.

Trivial names are intended as a help to the memory, and therefore if they are compound words they do not answer the end. It is likewise improper to annex to a generic name, which is always a substantive, another substantive. The following names are therefore faulty:

Carex Drymeja.
—— Chordorhiza.
—— Heleonaster.
Juncus Tenageja.
Scirpus Beothryon.
Lichen Aipolius, &c.

The trivial name should always be an adjective, and should, if possible, signify some quality of the species; as, Carex paniculata, Carex canescens, Campanula patula, Campanula persicifolia, &c.*

§ 220.

The figure, cloathing, and especially the specific difference, suggest the most appropriate trivial names.

When the specific difference can be expressed in one word, and that an adjective, such a trivial name always deserves the preference. But the adjective must not be too long, nor consist of two words. When such trivial name is not to be found, we must have recourse to the qualities, place of growth and other circumstances.

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* The author has omitted to mention here, that Linnæus often gives a substantive as a trivial name: It will be observed, however, that in general this substantive had formerly been the well known name of the plant; and when it is used as a trivial name, it is always marked with a capital; as Theobroma *Cacao*, Nicotiana *Tabacum*, Aesculus *Hippocastanum*, Citrus *Aurantium*, &c.

§ 221.

The colour and native country afford very uncertain trivial names.

It cannot be known from the appearance of a plant whether it grows in this or in that country, nor whether another species may not likewise grow in the same place. Neither can it be known whether the colour of a plant is constant or not. Trivial names, from these circumstances, are not therefore to be recommended. Linnæus has Polemonium *coeruleum*, though it varies with white flowers. Euonymus *europæus* is not the only European species of that genus; the E. *verrucosus* and *latifolius* are both natives of Europe; and we might give other instances to shew that such names are not good.

§ 222.

The botanist must attend to varieties when they are considerable; he must give them a second name, and mark them with a Greek letter, *e.g.* Brassica *oleracea*.

α. viridis.
β. rubra.
γ. capitata.
δ. sabauda.
ε. laciniata.
ζ. selenisia.
η. sabellica.
θ. botrytis.
ι. napobrassica.
κ. gongylodes.

In this way we can in a few words designate the genus, species and varieties of a plant, which the older botanists could not do without a long description.

§ 223.

The great advantage of the Linnæan names is not admitted by some botanists, and therefore they have attempted a change. First Ehrhart, considering that there are no proper genera in nature, but that these are invented by the ingenuity of botanists, proposes, in his Phytophylaceum, to denominate every plant by one word; thus,

Carex dioica he calls Polyglochin.
—— pulicaris —— Psyllophora.
—— arenaria —— Ammorhiza.
—— capillaris —— Caricella.
—— pallescens —— Limonaetes.
—— humilis —— Baeochortus, &c.

By such names the science would be immeasurably burdened. There may be about 2000 known genera, and at an average 80,000 plants, which must all have their appropriate names. But what memory would be sufficient for such a nomenclature?

The idea of Wolff is of a very different nature. He proposes to distinguish every character of a plant, whether it be the figure of the flower, the stamina, style, fruit, leaves, root, stem, stipula, florescence, smell, colour, &c. by a particular letter, so that the name of every plant shall be composed of these letters, and thus shall convey an idea of its structure and properties. However ingenious such a proposal may be it is impossible to execute it. One may easily imagine what barbarous words would be formed by this method, and what a number of consonants might of necessity stand together, which no power of utterance could pronounce. To attain any facility in such a nomenclature would require a life-time, and the advantage after all would indeed be trifling.

V. PHYSIOLOGY.

§ 224.

Besides the division into the three kingdoms of nature, (§ 2), natural bodies may with propriety be arranged under two chief classes, *organized* and *unorganized* bodies. *Unorganized* bodies are those, which are composed of heterogeneous particles, either chemically or mechanically combined, and which are formed, even when they are of some regular figure, by external apposition. *Organized bodies*, on the contrary, are all those, which are regularly composed of many differently formed organs, which, in the natural and healthy state, are of the same structure in all the individuals of one species. They grow larger, not by apposition, but by an internal power, acting from the interior parts outwards; and this organic structure, however, cannot exist without that internal power which is necessary for its total formation, subsistence and propagation, and which is called Life.

Plants no doubt belong to the lowest order of organized bodies. Their evolution from seeds to a certain size, the formation of the flower and of the fresh seeds, which are again changed into plants of the same kind from which they arose; is a continual circle of formation, existence and decay, which proves clearly, that plants are living, organized bodies*.

§ 225.

Organized bodies, in general, exhibit different powers, which may be divided into two chief orders: those which are solely produced by their organs, and when life ceases continue for some time after; and those which in the organs depend entirely on life. To the first belong,

Elasticity, (*elasticitas*), or the tendency of a flexible body to recover its former figure with some degree of force after extension or compression.

Contractility, (*contractilitas* s. *vis mortua*), or the dead power, which consists in the elongation and contraction of certain parts.

To the second order belong,

Irritability, (*irritabilitas*), when different stimuli produce a change in the parts of a body, which without it would not have taken place.

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* We speak of life here in its most extensive signification; for philosophers attribute life to animals only, considering consciousness as essentially connected with it, of which we have no proofs in plants. In these to consider life as merely an organic power, appears to be not at all sufficient. Between them and animals, which approach plants in their characters, &c. it is indeed not very easy, throughout, to draw an accurate line of distinction.

Sensibility, (*sensilitas*), when the stimulus of one part is communicated to all the organs, so as to produce a sensation of the stimulus of that part in the whole.

Vital power, (*vita propria*), or the power by which the circulation of the sap is promoted: it is this power which supports the growth, final formation, and all the functions of the machine.

The formative nisus, (*nisus formativus*), is the power by which lost or injured parts are restored, and which preserves their original form*.

§ 226.

All those powers appear in the animal kingdom, more or less distinctly, and even in plants are not altogether wanting.

Elasticity is peculiar to the wood, branches, leaves, seed-vessels, and other parts of plants. It appears even after their decay, and is still to be found in gums, resins, and other vegetable substances; in them, however, it does not exist in the same degree after their decay as during life.

Contractility, which plants possess principally during life, remains in a great degree, even after they die, chiefly in the wood. This seems to arise from a change in its chemical component parts. It is well known that wood when moistened expands, and when dry contracts.

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* The expression *formative nisus* is used here in its more extensive signification, for that power, which produces and preserves the original form of things, and reproduces such of their parts as they have lost by accident. Cf. Blumenbach, on Generation. Goettingen, 1791.

Formerly it was thought that plants could grow in breadth only by expansion of the interstices between the fibres of the wood, when moisture pervades them. Mr De Luc, however, has shown, that the fibres themselves may be elongated, though in a small degree, and again contract. And he has made the singular remark, that box-wood contracts its fibres longitudinally when moist, but elongates them in a dry atmosphere. It however undergoes the changes in breadth in the same manner as other wood. He examined a great number of different sorts of wood, but not a single one shewed the phenomenon of boxwood.

It is this contractility of wood, which in economical and technical use, is often followed by most unpleasant consequences; and, it is on this account that wood is subjected to different processes, by which its contractility is entirely lost.

The dry stalks of Anastatica *hierochuntica*, known under the name of the rose of Jericho, and the seed vessels of the genus Mesembryanthemum, or as gardeners call it, the Candian flower, retain this power very long, expand in water, and contract when dry. The same happens with the Algae and Mosses, and with the calyx of Carlina *vulgaris*. Many of these parts may serve as Hygrometers.

All plants are possessed of *irritability*, though not in the same degree. The leaves of Mimosa *pudica*, *sensitiva*, *casta*, of Oxalis *sensitiva*, Dionaea *muscipula*, and other plants which grow within the tropics and under the Equator only, contract when touched. Less conspicuous, but easily demonstrable, is the contractility in the indigenous species of sun-dew, Drosera *rotundifolia* and *longifolia*. The filaments of Urtica, Parietaria, Berberis and others show great irritability, and likewise the pistils of some plants, especially the stigma of Martynia. Light acts as a particular stimulus upon plants as experiments have shewn.

Gautier and Brandis think the parenchyma endowed with irritability, which in animals, after they died of painful convulsions, they found so strait as when cut to emit a creaking sound. Rafn speaks of having found the parenchyma of the species of Euphorbia, in which he made frequent incisions, in a very tense state: he does not, however, attempt to decide, whether the parenchyma is the only substance which possesses irritability. He assumes a muscular fibre, (§ 233), in plants, and contends with Abilgaard, that in all probability the seat of irritability is the parenchyma, and that muscles are its conductors.

Sensation, which in the animal is produced only by the nerves, has not hitherto been met with in the vegetable kingdom, nor have nerves yet been found in plants. It does not however follow, that they are destitute of nerves. But it certainly would be a precipitate conclusion, were we, with Dr Percival, from some not sufficiently demonstrated facts, to conclude as infallibly true, that plants have sensation or consciousness. We can go as far only, as our organs of sense allow us to go. Whether we would be able with more perfect organs to observe more, is an useless investigation.

The only thing which could give us some faint proofs of sensation in plants, would be the experiments with the Galvanic pile. Mr Humboldt did not succeed in rendering even very sensible plants, especially the Mimosa *pudica*, susceptible of it. Rafn tried metallic stimuli wishout effect in Parietaria, Berberis, Parnassia. In the Mimosa *sensitiva*, however, he succeeded whenever he put goldfoil upon the leaves without shaking them. But how easy is it in such experiments to be misled or deceived!

Vital power is peculiar to plants, as to organized bodies in general. The simple experiment of letting a plant dry completely in a pot, without watering it, when, after it is completely dry, even by a careful supply of water, it never grows again, shows clearly, that its life is lost, and that fluids ascend through it by other means than capillary tubes, which was Hales's favourite opinion. Van Marum too has proved by experiment that plants can be deprived of life by electric shocks. I have myself made a similar observation. Having isolated a very fast growing plant, the Drosera *rotundifolia*, I exposed it to an electrical bath, on purpose to observe whether the irritability of the leaves would be augmented, but I found no difference; and after I drew sparks from some of the leaves, the plant very rapidly decayed. The vital power, therefore, may in plants, as well as in animals, be extinguished by excessive application of electricity. Moderate use of electricity, on the contrary, according to recent experiments, proves beneficial both to animals and vegetables.

The sole and characteristic mark of vital power, as Mr Humboldt justly observes in his Aphorisms, we find in the combination of the constituent parts, which in the living body are always combined against the laws of chemical affinity; but as soon as life ceases, nature restores the balance of affinity by fermentation, which we clearly observe in dead animals and their organs, as well as in vegetables. Bodies, therefore, in retaining life, follow the laws of vital power; when destitute of it, those of chemical affinity.

The *formative nisus* is particularly well observed in the animal kingdom, especially in the Vermes. But even plants possess it, if we regard their peculiar structure, though they are totally incapable of reproducing different parts. No leaf whatever, once hurt and purposely mutilated when new, ever regains its former shape by the formative nisus. In some plants which have many filaments, it is alleged that after these has been cut off, something like filaments has been reproduced; though I don't venture to consider this as a certain fact. But even this could by no means prove a complete reproduction, as the filaments had no perfect anthers. We commonly consider it as a reproducing power, when a willow or other fast growing tree or shrub, after having been clipped, again shoots forth numberless new branches. But neither the willow nor other trees nor shrubs or undershrubs are simple plants, but compound ones, as we shall afterwards find, (§ 228). After the clipping of the willow, the sap merely ascends from the soil, and acts upon the inner bark, (*liber*), by which means the buds are evolved and grow up to branches. But if we cut off the top of a palm it decays, being a simple plant, and we give up all hope of reproduction. This function manifests itself more distinctly in the bark of shrubs and trees, which are not of a resinous nature, and heals their wounds when not of too great a size. We are therefore intitled to maintain with all justice, that the power of reproduction exists in a far inferior degree in the vegetable than in the animal kingdom*.

§ 227.

As all those powers, now enumerated, are peculiar to organized bodies, we may previously conclude, that a certain likeness exists between animals and plants, which certainly cannot be altogether denied. The incomparable Bonnet has some very ingenious observations on the eggs, the embryos, and their nourishment, and on the genital organs of animals, compared with those of plants, which we cannot repeat here. In ancient times philosophers had such an idea, and Aristotle himself calls plants reversed animals. Linné proceeded even further, and we must make some allowance for his very lively imagination when we find him calling heat the heart, and earth the stomach of plants, and, more justly, comparing the leaves to the lungs.

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* A most remarkable phenomenon takes place in the leaves of Aristolochia *Sipho*, which might be considered as a reproduction; it does not, however, appear to be so, nor has it yet been explained. We find in the leaves of this plant not unfrequently irregular sutures, as if made by art, where the upper surface of the leaf is turned towards the under surface.

What can this be? It does not appear to be produced by insects. I am sorry I have not been able, for want of a garden of my own, to make some experiments to ascertain the point.

§ 228.

This likeness which philosophers observed between animals and plants, chiefly consisted in properties, which organized bodies possess without respect to their structure. It is, therefore, certainly worth while, to consider more accurately, in what respects plants differ from animals.

Animals take food by a certain aperture, and have a particular canal by which they propel their excrementitious matter.

Plants, on the contrary, take up nourishment with their whole surface, and possess, except transpiration by the leaves, which they have in common with animals, no peculiar canal to expel their excrements, except we consider the drops which we find on the roots of some luxuriant plants, (of which afterwards, § 275), as a proper instance.

Plants have a structure altogether different from that of animals. They want bones, muscles, and nerves, and only consist of variously combined vessels, which are surrounded by a cellular membrane. The wood, which some have compared with bones, has certainly not the least likeness to them.

Plants consist of an external or outermost cuticle, (*epidermis*), which, as in animals, is thin and without vessels. Below this lies the skin, (*cutis*), which is full of vessels, and which in woody plants is converted into bark, (*cortex*). It covers the inner bark, (*liber*), which is solely composed of vessels. This is followed by the *alburnum*, or the soft wood, as it is called. The wood, (*lignum*), is inclosed by the last, and surrounds the pith, (*medulla*).

The inner bark, alburnum, and wood, are one and the same substance at different periods of existence. The inner bark is converted into alburnum, and this into wood. They are all three compressed vessels, which are more or less hard, or still soft.

The pith almost entirely disappears in very thick large trunks, by the increasing solidity of the wood, and in few plants only remains always throughout all parts of the trunk. We find it in herbaceous plants, but most aquatic plants want it entirely.

The stems of herbaceous plants have neither alburnum nor wood. The epidermis surrounds their vascular membrane, which rarely in them is converted into bark, and in its centre lies a ring of vessels, corresponding with what in woody plants is called the inner bark. Immediately beneath this we have a more or less dense cellular membrane, (*tela cellulosa*), which is often very succulent, and next to it, a fleshy substance, (*parenchyma*). This incloses the pith, which in fact is a cellular texture of a dif-

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ferent nature, at times dry or juicy, at other times consisting of close and narrow cells.

Animals, with the exception of some of the vermes, are simple beings, but most plants not so; for some plants and palms excepted, which are simple plants, the rest are all of a compound structure. If we put the seeds of an annual plant, (§ 122, No. 3, α.), in the ground, plants grow from it, which soon flower, produce seeds, and then die. The buds of trees and shrubs are to be considered as annual plants, for as soon as they have blossomed and shed their seeds, they decay entirely. The trunks of trees and shrubs, as well as the roots of perennial plants have a great many buds, which are all of the same nature, and may be considered as repositories of many other annual plants. They are, therefore, not simple, but like the polypes in the animal kingdom, compound bodies. Below the bark in these plants there are, according to the species, as we shall more particularly specify, the rudiments of a number of buds, which by due supply of sap, may be finally evolved. We are, therefore, not to go beyond new-formed branches of clipped willows, (§ 216), as reproduced, though they have been produced by the formative nisus, which gives each plant its peculiar form and growth.

§ 229.

The chemical principles appear to be different in vegetables and animals, when considered in general. But if we take all the single substances, found in vegetables by chemical analysis, then we certainly meet with most of them in the animal kingdom too. The chief vegetable principles are,

1. Caloric, is present in all parts of vegetables, and constitutes their temperature when free.

2. Light, is found in the oils and other inflammable vegetable substances.

3. The electric fluid shows itself by various electrical phenomena observed in plants.

4. Carbon, is the chief constituent part of all vegetables.

5. Hydrogen. This may easily be obtained in a gazeous form, combined with caloric, from all leguminose plants.

6. Oxygen is, we shall soon find, evolved by the rays of the sun. Part of it, however, is combined with acidifiable bases and forms vegetable acids.

7. Azote, is exhaled by plants in the night; the greatest part of it however is in a combined state.

> Whether azot belongs to the simple substances, (elements), or as Goettling supposes, is a compound of oxygen and light, we must leave to the future decision of chemists. At present we shall consider it as a simple substance.

8. Phosphorus occurs in plants of the 15th class, and in the gramina. Its existence manifestly appears by the shining of old rotten wood, the root of the common Tormentilla *recta*, and of rotten potatoes, Solanum *tuberosum*, &c.

9. Sulphur, in form of acid combined with oxygen, is met with in many plants, either with potass,

forming a sulphat of potass, or with soda, as sulphat of soda. Even in substance sulphur has been found in the roots of the Rumex *Patientia.* After they were cut down, boiled and scummed, sulphur appeared in the scum when left to settle.

11. Soda is peculiar to almost all plants growing on sea-shores or in salt marshes.

12. Silica is found in the stem of the Bambusa *arundinacea*, and in the common reed, Arundo *Phragmites.* It is supposed to exist in the alder, Betula *Alnus*, and birch, Betula *alba*, as their wood often emits sparks when under the hand of turners.

13. Alumina, it is said, has been found in some plants.

14. Magnesia, some philosophers think, they have have met with likewise.

15. Barytes is chiefly obvious in grasses.

16. Lime is found in almost all vegetables, most frequently in Chara *tomentosa*, a pound of which is said to contain five ounces of it.

17. Iron is detected in the ashes of most plants.

18. Manganese has likewise been sometimes found in plants*.

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* If some have detected gold in the vine, Vitis *vinifera*, oak, Quercus *robur*, hornbeam, Carpinus *betulus*, or in ivy, Hedera *helix*, and tin in Spanish broom, Spartium *junceum*, it seems merely to have been accidentally, as their presence has been stated as impossible by late experiments. Of the above principles, No. 1—7, and 10, 16 and 17 are found in all plants, the rest only in some. The Fungi, especially the genera Peziza, Octospora and Byssus have, according to the latest researches, not a vestige of lime.

§ 230.

All the now enumerated principles which have been found in vegetables, belong, as far as chemical knowledge has advanced, to the elementary or simple substances. The vital power produces by mixing them, new formed substances, which we cannot pass in silence. They are the following:

1. Volatile oils, composed of carbon and hydrogen, are found in all parts of plants, more frequently, however, in warm than in cold climates.

2. Resins, are met with in the roots, bark, wood, and in the blossoms and fruits of many plants; and likewise more frequently in those of warm than of cold climates.

3. Gum-resins, or such as are composed of gum and resin. Apothecaries use many of them, *e. g.* the gum Asafoetida, (Ferula *Asafoetida*); Gamboge, (Stalagmitis *guttifera*); Officinal storax, (Styrax *officinalis*), and others.

4. Camphor. This substance we obtain from the camphor-tree, Laurus *camphora* and many other species of laurel, *e. g.* from the old roots of the cinnamon-tree, (Laurus *Cinnamonum*), and others. Camphor has likewise been found in some of the essential oils.

5. Fixed or fat oils. These occur in the fruits of many plants, *e. g.* in almonds, (Amygdalus *communis*); in the walnut, (Juglans *regia*); in the olive, (Olea *europea*); in the Ricinus *communis*, &c.

6. Wax is likewise found in the fruits of some plants, *e. g.* of the laurel, (Laurus *nobilis*), and of the Myrica *cerifera* and others. We have it in the pol-

len of almost all flowers, and accordingly bees prepare their wax from it.

7. Glutinous matter, in the berries of some plants, *e. g.* of the misletoe, Viscum *album*, and in the plant from which we obtain the Indian rubber, Siphonia *elastica*.

8. Soapy matter, which takes greasy spots out of linen. It occurs in the leaves of the soap-wort, (Saponaria *officinalis*); in the fruits of the Saponaria *sapindus*; in the common horse chesnut, (Aesculus *Hippocastanum*); in many roots, as in cichory, (Cichorium *Intybus*); burdock, (Arctium *Lappa*); vipers grass, (Scorzonera *hispanica*), *&c.*

9. Mucilage is met with in many plants; in the roots of the marshmallow, (Althaea *officinalis*); in the stalks of the goats-thorn, (Astragalus *creticus*); in the leaves of the round-leaved mallow, (Malva *rotundifolia*); in the seeds of the quince, (Pyrus *cydonia*); in the flowers of the yellow mullein, (Verbascum *thapsus*), *&c.*

10. Gum exudes in form of small globular masses from the stem of certain trees, *e. g.* the damson-tree, (Prunus *domestica*); black cherry tree, (Prunus *avium*); gum arabic from the Mimosa *nilotica*.

11. Gluten, which composes the vegetable fibre, is produced by a combination of carbon and azot.

12. Albumen occurs in many of the culinary plants, and in the mealy seeds of some of the species of cress, *nasturtium*, and in the squill, (Scilla *maritima*).

13. Starch, consisting, it seems, of gluten, farina and saccharine mucilage. It is found in the seeds

and tuberous roots of many plants, *e.g.* the horse chesnut, (Aesculus *Hippocastanum*); in the potatoe, (Solanum *tuberosum*); in the bryony, (Bryonia *alba*); in Paeonia *officinalis*, Arum *maculatum*, and many others.

14. Sugar. This is likewise obtained from a great number of plants, of which, however, few yield pure sugar, most of them only a mass like honey, consisting of the sugar dissolved in a gelatinous fluid from which it cannot be extracted in a state of purity. Pure sugar is found in the juice of the sugar-cane, (Saccharum *officinarum*). Some species of the Acer, especially of the Acer *saccharinum*, *dasycarpum*, some species of birch, (Betula *alba*, *lenta* and others), Cabbage, (Brassica *oleracea viridis*); beet, (Beta *vulgaris*. Plums, cherries, and other fruits contain sugar.

A honey-like substance is prepared in the nectaries of most plants, *e. g.* of the manna-ash tree, (Fraxinus *Ornus* and *rotundifolia*), of the liquorice root, (Glycyrrhiza *glabra*), &c.

15. Bitter principle. Many plants possess this principle, as the common wormwood, (Artemisia *Absynthium*); water trefoil, (Menyanthes *trifoliata*); centaury, (Chironia *Centaurium*); common fumitory, (Fumaria *officinalis*); Quassia *amara*, and others*.

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* The nature of the bitter principle of plants is not yet sufficiently known, for it differs from that which we find in bitter almonds, in the stones of peaches, apricots or plums, in the leaves of the cherry laurel, in the seeds of Strychnos *Nux vomica*,

16. Narcotic principle, which has a particular effect on the brain, producing drowsiness, &c. The juice of the white poppy, (Papaver *somniferum*); of Hyoscyamus *niger*, Atropa *Belladonna*, Conium *maculatum*, Cherophyllum *temulum*, Aethusa *Cynapium*, are instances of it.

17. Acrid principle, which produces a pungent sensation. The horse-radish, (Cochlearia *armoracia*); lemon scurvy-grass, (Cochlearea *officinalis*); arum, (Arum *maculatum*); water pepper, (Polygonum *hydropiper*); Cayenne pepper, (Capsicum *annuum*); black pepper, (Piper *nigrum*); foxglove, (Digitalis *purpurea*); Ranunculus *acris*; Aconitum *Napellus*, and many other vegetables possess it.

18. Gallic acid. This, combined with gum, is met with in a great number of plants, and is a very astringent substance. It occurs chiefly in the bark of trees, such as oak bark, willow, &c.

19. Citric acid: consisting, as all vegetable acids, of Carbon, Hydrogen, and Oxygen, which, in each acid are of different proportions. This acid has been found in lemons, (Citrus *medica*); raspberries, (Rubus *idaeus*); gooseberries, (Ribes *grossularia*; and myrtle berries, (Vacinium *myrtillus*).

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vomica, the poison nuts, and of Ignatia *amara*, the Faba *febrifuga*, &c. This last kills all animals, and in greater quantity may even become noxious to men. The experiments of my friend Dr Flohrman in Lund give most striking results: he killed with eight grains of the poison-nut a strong horse. Prof. Vibourg's observations on the effects of the cherry laurel likewise deserve attention.

20. Malic acid, occurs in apples, (Pyrus *malus*); quinces, (Pyrus *cydonia*); strawberries, (Fragaria *vesca*), and others.

21. Oxalic acid. In the wood sorrel, (Oxalis *acetosella*); herb Robert, (Geranium *robertianum*); in rhubarb, (Rheum *rhabarbarum*), and some others.

22. Tartaric acid. In sorrel, (Rumex *acetosa*); tamarind, (Tamarindus *indica*).

23. Benzoic acid. In benzoin, (Styrax *benzoë*); balsam of Peru, (Myroxylon *peruiferum*); and balsam of Tolu, (Toluifera *balsamum*).

24. Ammonia, or volatile alkali, composed of azot and hydrogen, is found in the species of gramina and mustard, as the white and black mustard, (Sinapis *alba* et *nigra*); in Sysymbrium *nasturtium*, &c.

§ 231.

Besides the elementary substances, and those combined by the vital power, vegetables contain some of the neutral salts: sulphat of lime, nitrat of magnesia; the last is found chiefly in the Zea *Mays*, nitrat of potass is found in Borago *officinalis*, Helianthus *annuus*, Mesembryanthemum *crystallinum*, Achillea *millefolium*, Fumaria *officinalis*, &c. Sulphat of soda in Tamarix *gallica*, muriat of soda in many sea-plants. In America some plants, it is said, have been detected, from which muriat of soda may be obtained. Sulphat of potass is found in the ashes of most vegetables.*

§ 232

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* Still, however, there is an open field for research in chemistry. We are partly entirely ignorant of many of the

§ 232.

Chemistry makes us acquainted with the component parts of vegetables, but Anatomy explains their wonderful structure, to which we now therefore direct our whole attention.

The last science has detected the following different vessels in plants: Adducent vessels, (Vasa *adducentia*); reducent vessels, (Vasa *reducentia*); air vessels, (Vasa *pneumato-chymifera*); lymphatic vessels, (Vasa *lymphatica*); cellular texture, (Tela *cellulosa*). They may be all observed with a microscope when injected. This can easily be accomplished by putting a plant in a decoction of brazil-wood, (Cæsalpinia *echinata*); which fills the adducent and air vessels. The reducent vessels only appear, when the plant is cut at the top, and put inverted in the liquid. The lymphatic vessels, may be seen without injecting them, merely by carefully taking off the epidermis and putting the plant under the microscope. The other vessels, however, except the air vessels and adducent vessels, can very seldom be filled with coloured liquid.

Gessner and others, who paid great attention to the Physiology of plants, have proved the presence of all these vessels by means of the air-pump. And only lately, Mr Achard tried to inject plants, which

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the animal and vegetable principles, and partly destitute of proper means to separate and analyse them accurately. The nature of the extractive, dying, bitter, acrid and narcotic principles and their varieties, and many others, is still unknown to us.

were put in a coloured liquid or mercury, by means of compression of the air. But not to mention the danger connected with such experiments, the vessels can never be seen in their true form, as no doubt many of them must burst. The common method, then, of injecting them is by far preferable, though we are not in all plants equally successful with it. The common balsamine, (Impatiens *balsamina*), is the plant best suited for such experiments.

§ 233.

Adducent vessels: (*Vasa adducentia*, *moniliformia*, *succosa*, *propria*, *nutrientia* vel *fibrosa*), ascend perpendicularly, and are pretty large in most plants. As they are always in great numbers close below the cuticles, they appear, when the stems are cut through horizontally, in circles. In some young shrubs and trees, and in some of the more succulent herbaceous plants, they form ellipses, or triangles, pentagons and hexagons. They serve in vegetables the same purpose as arteries in the animal body. They are commonly quite straight, and consist of links, which are somewhat contracted, of which each has at its upper and under part little prominent margins, leaving, however, an opening from one link to the other. The inner surface of these links or vesicles, as we may call them, is covered with soft slender hairs, which when the vessels get a more ligneous texture, closely adhere to them, and make the surface very rough.

Those links are of a different figure, and their form varies in proportion as the cellular texture more or less compresses them. We see them, therefore, of an elliptical, spherical, compressed, or conical figure. They are largest where the stem ends and the root begins, but decrease in thickness towards the superior part of the stem, and towards the ends of the root. In general we can see the vessels much more distinctly in young plants, where they are largest, than in old ones, which are more ligneous.

Some botanists have thought that these vessels are formed out of the cellular texture. But it is not very probable that they owe their origin to the cellular membranes, as these are by far too irregular, and as they are found already formed in the corcle of the seed.

We shall soon find that they harden along with the air vessels and the wood, and that they constitute the ligneous fibre, which is to be well distinguished from the muscular fibre. With this the ligneous fibre, being an indurated vessel, has not the least resemblance; besides which no other part occurs resembling the animal fibre. But as Mr Van Marum's experiments have proved, that the vital power causes them to contract, by which the sap is pushed forward, it may be asked, whether these ligneous fibres themselves are not composed of thin muscular fibres, or at least of a sort of aponeurotic membrane? But this point will surely never be decided, as the vessels are so very minute themselves that we must rest satisfied, even with the aid of a microscope, merely to ascertain their existence. It certainly would be very difficult to produce any thing better than a hypothesis concerning their structure, as anatomists, even lately, disputed, whether by far a larger organ in the human body, the uterus, possessed any muscular fibres or not.

§ 234.

Reducent vessels, (Vasa *reducentia*, s. *medullaria*), are of great number, and by far softer and more minute than the first. They lie in the cellular texture and in the pith, and run either in an oblique or horizontal direction. In their functions they resemble veins. It is with great difficulty they can be filled with coloured liquors, and soon escape the eye of the observer. In some species of wood they become visible in their indurated state by a horizontal section.

§ 235.

Air vessels, (*Vasa pneumato-chymifera*, *vasa spiralia*, *fissuræ spirales*, vel *tracheae*), are delicate, membranous, spiral and hollow tubes, which have other minute vessels, twisting round them in a spiral direction, like a cork-skrew, some close to each other, some more or less distant, fig. 282. The hollow interstices between them contain air, but no fluid, the spiral vessels themselves however contain a fluid. The very thin membrane investing the hollow interstice, occurs only in the more distantly twisted vessels; in those which are close to each other, though present it can scarcely be observed. They are commonly round; sometimes, however, by the circumambient presence of the other vessels,

sels, they become angular. In all ligneous plants they occur in great numbers, and lie in bundles immediately below the adducent vessels; in some of the herbaceous plants, however, they are not found so numerous and only in distinct masses. They grow thicker towards the root. Grew says, that he found them near the root, twisted downwards from right to left, but in the part of the plant above ground, upwards from left to right.

We may form an idea of the minuteness of these vessels from Hedwig's observation, that with a microscope which magnified 290 times he found the diameter of the hollow interstice of the tube, the 10th part of an inch wide. The real diameter, therefore, is no more than the 290th part of a line. How minute, therefore, must the vessels themselves be?

§ 236.

Lymphatic vessels, (*Vasa lymphatica*). These are found in the epidermis of plants, and are of great minuteness, anastomosing in various ways through small intermediate branches. They surround the apertures of the cuticle, by which the inhalation and exhalation of vegetables is carried on; but they are so minute as not yet to have been filled with coloured liquids Round each opening, which is commonly shut by a moveable valve, they form a circle, rarely a rhombus, as in the Zea *Mays*. In the Lilium *calcedonicum* those vessels run obliquely, and somewhat in an irregular undulating manner, fig. 270. In the common onion, (Allium *Cepa*), they run in a straight, though oblique and regular form, fig. 280. In the pink, (Dianthus *caryophyllus*), they are very straight, with straight and horizontally transverse branches, fig. 281. In almost every plant they have their certain and peculiar direction, which in each remains constantly the same.

§ 237.

The cellular texture, (Tela *cellulosa*, s. *utriculi*, *contexus cellulosus*), signifies a very delicate membrane, which is divided into innumerable variously formed cells or little spaces, which are intimately connected with each other. Some philosophers indeed have considered those cells or vesicles as peculiar vessels. When this cellular texture is very tense and succulent, we call it, especially in some fruits, flesh, (Parenchyma, *pars carnosa*, § 228). Pith is a more compact cellular web, which is distinguished by its bright white colour, by its smaller and more compressed cells, and by its spongy appearance.

The communication of some of those vessels or their anastomosis differs in plants from that of animals. For the adducent and air vessels always run along in bundles, which again divide themselves in smaller bundles. The smaller ones connect themselves with larger, and again separate, to join others. The lymphatics on the contrary anastomose in plants in the same manner as in animals. The vessels proceed single for some way, and then divide into branches which communicate with one another, and with other vessels.

§ 238.

Some of the vessels now described convey the sap which differs in its nature in different species of plants: It is

Resinous, in the different species of fir, &c.
Gummy, in fruit-trees and some species of Mimosa.
Lymphatic, in almost all plants.

Sap likewise varies in colour: It is

White, in Euphorbia, Papaver, Leontodon, Pinus, &c.
Yellow, in Chelidonium.
Red, in Rumex *sanguineus*, Dracæna *draco*, Pterocarpus *santalinus*, Calamus *Rotang*.
Blue, in the root of Pimpinella *nigra*.
Green, in some umbellatae.
Colourless in most plants.

The sap in fruits, we know, is of various tinges. Rafn discovered a great analogy between the sap of plants and the blood of animals. He detected, with a microscope magnifying 35 times, in the lymph of Euphorbia *palustris*, round globules, like those in blood, which swam in a fluid which was clear, but not so clear as water. The same I observed myself in the sap of the Rhus *toxicodendron*. Rafn, however, found in the Euphorbia, besides the globules, prisms, which he likewise saw in Euphorbia *peplus*, *helioscopia*, *esula*, *cyparissias*, and *lathyris*, though they differed somewhat. In no plant but the Euphorbia and Hura *crepitans* he could detect the prisms. One drop of lymph of Euphorbia *canariensis*, *Caput Medusae*, Chara *neriifolia* had one or two prisms only. Alcohol congealed the lymph of the Euphorbia and precipitated a fibrous matter. Sulphuric acid had the same effect, but the fibres were not so thick as the former. The sap of Chelidonium consisted of nothing but closely cohering globules. This goes to prove, that the sap of some vegetables, for instance, the Potentilla *anserina*, is not, as Plenk supposes, merely decomposed or changed water. Rafn found in those plants which consist of much cellular texture, *e. g.* the Musa *paradisiaca*, Strelitzia *Regina*, the globules smaller and less frequent than in the species of Euphorbia.

§ 239.

We shall soon find that plants with their whole surface, as far as it is green, with the stem and leaves, take up part of the atmospherical air and particles disposed in it, and again transmit air and moisture. And we cannot be much surprized to find, that the quantity of matter which they inhale from the atmosphere, and of that air and moisture which they exhale, is very great, if we consider that the number of apertures, which exist in the cuticle of plants, by lymphatics, (§ 236), in the green stalks, in both surfaces of the leaves, even in the flower and its parts, is so very considerable. Hedwig counted in the Lilium *bulbiferum* in one surface of a single leaf 577 apertures in one cubic line. A cubic foot would therefore according to this observation have about 998145 apertures. Now how many cubic feet does the surface of all the great and leafy plants present to the atmosphere, and how great must their number be, for instance, in a full grown leafy oak-tree? According to Hales's experiments, the moisture which ascends from the leaves of plants by transpiration, is very great. A sunflower, three feet high, transmitted in 12 hours about one pound and four ounces avoirdupois. When dew fell, this transpiration ceased entirely, and the leaves absorbed two or three ounces of it. When there was no dew, then the transpiration during night amounted to only three ounces. He made many other similar experiments, and the transpiration was always considerable in the day time. Mr Watson put a glass vessel of 20 cubic inches capacity inverted on grass, which had been cut during a very intense heat of the sun, and after many weeks had passed without rain; in two minutes time it was full of drops which run down its sides. He collected these on a piece of muslin, carefully weighed, and repeated the experiments for several days between twelve and three o'clock. And from this he was led to calculate, that an acre of land transpired, in 24 hours, 6400 quarts of water.

§ 240.

As the life of animals greatly depends on external warmth, plants likewise need a certain degree of it. Plants of warm countries want more of it than those which belong to cold regions. These are facts which need no further demonstration. But whether plants, like animals, have a fixed and peculiar degree of heat, is a question which remains to be answered. We find that trees or shrubs, in cold climates, if they grow wild, can bear the greatest cold without harm. As soon as the warmth of the spring commences, their buds are evolved, and they shew no bad effects from the cold whatsoever, though their stem and branches be full of moisture. If in a strong frost we put vessels with water alongside of such a tree, we will find that the water is frozen, but that the tree retains its sap unfrozen, and is not in the least hurt. The contrary takes place in plants of warmer and hot regions. Their sap congeals at the least degree of cold, and the plants decay. Thus there is evidently a remarkable difference between the plants of cold and those of hot climates. As long as plants live and possess sufficient vital power, to resist cold, their sap will not congeal with cold. But when in spring cold nights come on, after the buds have burst, the new shoots perish through frost. We observe, likewise, that dead or sick branches are more exposed to be frost-bitten than living and sound ones, and that branches, by their sap being congealed, are killed. The birch and some other plants, it is well known, often have their roots covered with ice, without suffering the least injury. In the northern hemisphere of our globe are many and extensive tracts of pine trees, which resist with their evergreen branches the most violent winter cold. Those observstions clearly prove, that each plant possesses a peculiar degree of warmth according to its species, which defends it against the inclemency of the weather.

But this heat in vegetables is not of such a nature as to enable us to judge of its degree by our senses alone. We know that every animal has a certain degree of heat. We find a frog or lizard cold, notwithstanding nature has given them a peculiar degree of heat. The temperature of plants is such as to enable them to resist both heat and cold. If in a hot summer day we touch some ground which is much exposed to the rays of the sun, and immediately after put our hand on green grass exposed to sun-shine, we will find the ground much hotter than the grass. Fruits, though much in the sun, will be cool, whereas a glass full of water will be quite warm in a far shorter time.

Sonnerat detected in the island of Lucon a rivulet, the water of which was so hot, that a thermometer immersed into it, rose to 174° Fahrenh. Swallows when flying seven feet high across it, dropped down motionless. Notwithstanding this heat he found on its banks two species of Aspalathus and the Vitex *agnus castus*, which with their roots swept the water. In the island of Tanna, Mr Forster found the ground near a volcano as hot as 210° Fahrenh. and at the same time covered with flowers.

This then proves clearly, that plants, like animals, have their peculiar temperature, according to their native countries, which they cannot exceed without injury. The experiments of Dr J. Hunter and Schoepf shew us the same thing. The first put a Scotch fir, three years old, in a freezing mixture of between 15° and 17° Farenh. The youngest shoot was frozen; the fir was again planted, the young shoot remained flaccid, but the first and second were fresh. Of young plants of oats, which had only three leaves, one leaf was exposed to artificial cold at 22° which instantly was frozen. The root was put into the same cold mixture, but did not freeze. He then planted it, and all its parts grew well, except the leaf, which had been frozen. The same experiment he repeated with a growing bean; a leaf of it was frozen in an artificial freezing mixture, and another fresh leaf was bent in the middle upon itself, put into a leaden vessel, and along with it the frozen leaf, which had been previously thawed. He afterwards put the vessels upon the top of the freezing mixture. The surfaces of the two leaves froze as far as they came in contact with the vessels between 15 and 17°, the atmosphere being at 22°. The frozen leaf froze much sooner. These experiments were repeated, and always with the same result. The juice of spinage and cabbage, when squeezed out, congealed at 29°, and thawed again between 29—30°. These juices, frozen in a leaden vessel, were put into another, with a cold mixture at 28°. A growing fir-shoot, and a bean-leaf were put upon the frozen liquid which in that place thawed in a few minutes. The leaves had the same effect when removed to other frozen spots.

Schoepf made the following experiments in North America. He bored holes in different stems, which he again closed up. In one of the holes he put a thermometer at frosty weather, to compare the internal heat with that of the atmosphere. The result, however, differed at different times, and in proportion to the different thickness of the stem. He made some other experiments by means of a thermometer, comparing the temperature of the atmosphere with that of the leaves. The above related experiments of Mr Hunter plainly shew, that the juices of plants have a peculiar temperature of their own. But those of Schoepf cannot serve, as he himself acknowledges, as decisive proofs, because the ligneous stems of plants possess a less degree of vital power, and indeed the inner bark only (as we shall soon have occasion to observe, § 297), is in every tree or shrub the seat of this power. The power of conducting caloric, which certainly in wood is not so strong as in other bodies, alone, produces a change of temperature, and renders the experiments of Mr Schoepf very uncertain*.

§ 241.

But the consideration of the different powers of vegetables, their chemical component parts, the structure of their vessels, of the process of absorption, of exhalation and temperature, is not sufficient to convey a complete idea of a plant. We shall, therefore, go through the whole vegetable world, from the evolution of plants from seeds to their decay, and briefly lay down the different results of all the observations hitherto made by philosophers on purpose to become thoroughly acquainted with the scenes of their life and decay, thus annually renewed, and in such various ways.

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* Grass, roots, and the pine tribe, and all plants in general which have a more tenacious sap, and can resist cold better than others. But trees which lose their leaves, are, as long as the leaves remain, very susceptible of its impression. The reason seems to be, that all sap, as long as the stem has its leaves, circulates very quickly, and being thinner, is more liable to suffer by cold. We find, in early winters, that those trees which lose their leaves, do not suffer in the least by cold.

§ 242.

We are already acquainted with the nature of the seed of plants, (§ 114), and we know that it serves the same purpose as the egg in animals, to wit, to contain the rudiments of a new being, perfectly similar to its parents, waiting for a favourable opportunity to evolve itself.

All plants are propagated by seeds and we can say with Harvey, *omne vivum ex ovo!* It is true that they have not yet been found in all plants, but even in those in which their presence was formerly obstinately denied by philosophers, in Mosses, Fungi and Algae, the indefatigable researches of philosophers have, in most of these, clearly proved their existence. We have, therefore, every reason to expect, that we shall be hereafter lucky enough to point them out in those vegetables in which we now only suppose them to exist.

A seed has integuments, corcle, and cotyledons, (§ 114). It is fixed, as mentioned above, by an umbilical cord, and as soon as this separates, a cicatrice remains called the eye, (*hilum*). In its vicinity lies the corcle. Even in the hardest seeds this little spot is the only one not covered by the internal hard membrane.

When the seed is placed in the ground, moisture soon pervades its substance through this aperture, assisted by the warmth of the atmosphere. In the corcle and cotyledons all the before described vessels are present. In the last the adducent and air vessels divide themselves in numberless bundles, which frequently anastomose, (§ 238). A cellular membrane covers on both sides those vessels which spread on one plain surface, and contains the reducent vessels. On both surfaces the lymphatics spread out and surround the apertures of the cuticle. The pervading moisture is taken up by the vessels; the water is decomposed by them, and hydrogen and oxygen transpired. Carbonic acid gas, which seems to be shut up in the neighbourhood of the umbilicus by the external and internal membranes of the seed is likewise set free. The gaseous fluid, which was received from germinating seeds, contained in 10 cubic inches, sometimes 2, sometimes 3, 5, even 8 cubic inches of carbonic acid gas; and from 5 and 6 to 8 cubic inches of azote and hydrogen gas mixed. This gas, when coming in contact with the oxygen of the atmosphere, exploded at the approach of a candle. The rest of the undecomposed water, with the fixed part of carbon and hydrogen, pervades the vessels more and more, attenuates the substance of the seed to a milk-white fluid, and excites the action of the vital power. The vessels, filled with their sap, carry it to the corcle, which is elongated by it, and converted into a plant.

The corcle consists, as we saw, (§ 114), of the rostel, (*rostellum*), and the plumule, (*plumula*).

From the first arises the root, from the last the trunk, or the part above ground. Cutting a germinating plant in a perpendicular direction, so as to divide it in two equal parts, we observe in the middle of each cotyledon a hollow channel which is called the chyliferous duct, (*Ductus chyliferus*), which is continued as far as the beginning of the rostel, proceeds between its pith and fleshy substance, and at last incloses the pith. This duct serves to conduct the nourishing fluid, which the cotyledons contain, to the young plant. Experience teaches us, that germinating plants, even though they have some leaves already evolved, cannot part with their cotyledons without endangering their lives, like a young animal which cannot want the feeding breast of its mother*.

§ 243.

It is a remarkable phenomenon in the germination of seeds, that the radicle first elongates, and pushes into the earth, where as soon as it fixes itself, and not sooner, the plumule appears in its peculiar shape, (§ 245) Even though the seed should be inverted and put into the ground, so as to turn the rostel towards the surface of the ground, yet it never will grow upwards. It grows long, but soon turns towards the ground, and then the seed recovers its proper position. This observation, which we can make every day, especially in the kidney bean, (Phaseolus *vulgaris*); in the common bean, (Vicia *faba*), and other culinary seeds, has greatly attracted the attention of botanists. Dr Percival compares it to instinct in animals, and endeavours to prove by it, that plants have sensation and consciousness. Dr Hedwig accounts for this tendency of the rostel downwards in a twofold manner: In the first place, the sap is, by the two chyliferous ducts accumulated in the extremity of the rostel, which therefore becomes heavier, and of course, according to the laws of gravity, is drawn downwards. In the second place, the moisture in the extremity of the rostel, is attracted by that of the ground. But both these reasons appear to me to be insufficient to explain this phenomenon; for first, the power of gravity and attraction is one and the same power; and secondly, the cotyledons contain by far more moisture, and they possess a greater absolute gravity; but notwithstanding this are often by the rostel pushed above ground. We are in fact as little capable of accounting for this phenomenon, as to give reasons why some caterpillars spin a case, while others bury themselves in the ground. We are ignorant of the nature of this as of many other operations in organized bodies. The only reason which can be brought forward to hide our ignorance is, to consider it as an action of the vital power. Dr Percival's assertion indeed appears to me to be a very precipitate conclusion.

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* According to my own experience, the rostel dries up entirely, if immediately after the seed begins to germinate, we cut off both cotyledons, and all vegetation ceases. Fabbroni, however, says, that a young plant may lose half of its cotyledons without any bad effects, and he even has cut off the whole, and the vegetation went on. But probably this experiment was made on plants where the plumule was already somewhat large. Hedwig observes, that the plumule may be cut off, and that in its place two young shoots will appear. I doubt very much if this be the case with all plants.

§ 244.

It deserves our attention too, that not all seeds have the rostel, especially of some aquatic and parasitic plants, and perhaps all those which Dr Gaertner styles *acotyledones*. I was, as far as I know, the first who discovered this, when I examined with great care the water-caltrops, (*Trapa natans*), one of the most singular plants. The nuts, as they are called, of it, when they lie in water, the natural habitation of the plant, shoot forth a long plumule, which in a perpendicular direction rises towards the surface of the water, its sides push out at certain distances, capillary, branched leaves Some of those leaves bend downwards and attach themselves at the bottom. Here then the plant becomes fixed in the ground, not by a peculiar root, which, as rostel, preexisted in the seed, but only through the leaves. It would be as difficult as in the rostel, to state the reason, why some of the undermost leaves bend downwards, and from their capillary extremities shoot forth roots.

From this, however, we are enabled to conclude, that some seeds may want the rostel; but that a germinating seed should perform its functions without plumule and cotyledons, is impossible. Nobody as yet has attempted to deny the existence of the plumule in any seed. Linné, Gaertner, Jussieu, and many other botanists, denied that of the cotyledons, especially in the class Cryptogamia, (§ 139). Jussieu alone adds to those plants which have no cotyledon, Gaertner's acotyledones, such as want the rostel. Nature provided plants with their cotyledons, that they might nourish the young plant in its tender infancy. Never yet have I noticed a single instance where this wise measure of nature was omitted. I examined purposely all those plants which were said to want the cotyledons, and always met with them. That in some plants the existence of the cotyledons was altogether denied, and others were said to have one only, others two, and several plants more than two, arose partly from inaccurate observation, partly from mistaking a part of the plumula for a cotyledon. Placenta or cotyledon, (§ 114), is the name of the whole entire substance of a seed, not including the parts of the corcle. It rises in many plants with the plumule above ground, and is converted into leaves, or, it remains in the ground, and, as in the gramina, the first leaf of the plumule only rises, which is what some thought to be a cotyledon. In the flax and the species of fir, both cotyledons are converted into leaves, and the leaves of the plumula are evolved immediately after them, and of the same magnitude and appearance. Hence it was, that botanists supposed there were many cotyledons. The division, therefore, of plants in acotyledones, monocotyledones, dicotyledones and polycotyledones, is erroneous.

§ 245.

I have observed five principal varieties, according to the changes in the cotyledons, which I call membranous corcles, (*dermoblastae*); filiform corcles, (*nemoblastae*); splitted corcles, (*plexeoblastae*); earth corcles, (*geoblastae*); and globular corcles, (*spheroblastae*).

§ 246.

Dermoblastae, I call such as have the cotyledon in form of a membrane, which bursts in an irregular manner. This membrane is found in the Fungi, in which, however, it soon after their evolution disappears.

We want still further observations on this point, especially in the small Fungi, and even in these, different modifications may some time appear, which we at present suppose only, not determine with certainty. Most of the plants which have this peculiarity are so very small, that their existence and characteristic varieties only can be observed with difficulty, but by no means is an accurate knowledge of so very minute plants to be expected.

§ 247.

Nemoblastae. Those we find in Mosses and Filices, and perhaps also in Algae. Of these, however, we still need some more accurate observations. The subtance of the cotyledon in them divides into two halves, and bursts into an irregular shape, resembling threads.

§ 248.

Plexcoblastae are those in which the cotyledons appear above ground in two halves, and change into leaves, which are of a different shape than the rest of the leaves. They are elliptic in the species of Phaseolus; linear in the umbellatae, and in the Plantago; cordate in the plants of the sixteenth class of Linnæus; inversely cordate in those of the 15th class; reniform in the ringent plants; club-shaped, and at the point variously intersected, in the lime-tree.

§ 249.

Geoblastae, I call those which keep the substance of the cotyledons under ground, *e. g.* the vetch-pea, the gramina, lilies, &c. They are of a double kind.

Rhizoblastae, where the seed has a rostel, and shoots down a straight root, as in most plants.

Arhizoblastae, when the seed wants the rostel, as in some water and parasitic plants.

§ 250.

Sphaeroblastae, are those whose cotyledons do not divide in two, but come out of the ground in form of little globules fixed upon a small stalk, and have the plumula on their side. This we meet with in Juncus *bufonius*, and some plants related to it. Several botanists who were unacquainted with this singular modification of germination, have mistaken the above-mentioned plant for a new one belonging to the 24th class of Linnæus.

§ 251.

It is an old observation, that each plant affects its peculiar soil, and that on this account, all seeds do not germinate in all kinds of soil, and at least soon decay in that which they dislike. Various trials have been made, to make seeds germinate in various matters, different from the usual earths. Sukkow made sallad plants grow in pounded fluat of lime and barytes. Bonnet made plants grow in saw-dust, slips of paper, cotton, and even in an old book. That cress, (Lepidium *sativum*), germinates upon a piece of woollen cloth is a well known fact. Mr Humboldt's experiments to make seeds germinate in metallic oxyds, especially the red oxyd of lead, in litharge, massicot, &c. are more instructive. In powder of coal and sulphur, seeds germinated likewise very well. He found that oxygen proved an extreme stimulus to plants, and that without it they never can be brought to germinate. On this account germination went on quickly in metallic oxyds, especially in minium. In oil, on the contrary, carbon, hydrogen, in the filings of lead, iron, and copper, as well as in powdered molybdene and in alkalis, no one seed germinated. It soon occurred to him, that with oxygen as a stimulant he might forcibly make seeds germinate faster, and he actually found, that at the temperature of 20° Reaum. all seeds vegetated most rapidly when steeped in oxy-muriatic acid. One instance only will suffice. The seeds of the Lepidium *sativum* germinated after 6 or 7 hours, when put into oxy-muriatic acid; whereas when lying in common water, they required from 36 to 38 hours. In a letter, dated February, 1801, he writes me, that in Vienna they found much benefit from the discovery of this fact, and that seeds twenty and thirty years old, brought from the Bahama islands, Madagascar, &c. which constantly refused to germinate, very readily, in this way, vegetated, and produced plants which grew up very successfully. The Mimosa *scandens*, which as yet is not to be found in any botanic garden, grew very well with this acid. As every gardener cannot obtain the oxy-muriatic acid, Mr Humboldt proposes a very easy method to procure it without difficulty. He took a cubic inch of water, a tea-spoonful of common muriatic acid, two tea-spoonsful of oxyd of manganese, mixed it and placed the seeds in them. The whole was now allowed to digest with a heat of 18—30° Reaum. The seeds all germinated beyond expectation. It is necessary to take the seeds out, as soon as the corcle appears. That the seeds are not impaired by the acid, is proved by the many plants which have been treated in this way, under the inspection of Mr Jacquin, and in which vegetation goes on wonderfully well, though many of them had their seeds steeped in the oxy-muriatic acid.

It is the oxygen of the atmosphere which stimulates the seed to germination. And this circumstance explains at once the experiment of Mr Achard, why plants vegetate faster in very compressed air, than in air in its common state.

Besides oxygen, ammonia too favours the germination of seeds; hence seeds germinate almost immediately when placed in dung, which therefore serves as manure. Cow-dung, we know, consists of muriatic acid and ammonia. In fluids which contain no oxygen, seeds will not germinate. It never happens in oil, for instance, which consists of hydrogen and carbon.

§ 252.

It is the rostel of seeds which produces the part of a plant under ground, to which botanists have given the general name of root, (§ 10). But physiologists call that part only a root, which carries nourishment from the soil to the plant, or what we before called radicles or fibres, (*radicula*).

In under-shrubs this part under ground consists of a bulbous, tuberous, or oblong root. In annual plants it is more or less perpendicular; and in shrubs and trees its formation entirely resembles the stem. In this, foresters again distinguish two separate parts, the thick one, which descends perpendicularly, called the main root; and those parts which run forth horizontally in the earth, which are their horizontal roots.

§ 253.

The anatomy shows us, that in biennial herbs and plants the adducent and pneumatic vessels form a circle or ring in the root, the inside of which is filled with pith, the outside lined with cellular texture. The reducent vessels lie in the last; the lymphatics with the pores of the cutis in the epidermis. In many plants of this kind this circle of vessels is closely pressed towards the centre, and the cellular texture very succulent and fleshy. But we never meet with more than one vascular circle, as there is annually a new one produced, as we shall soon see. For as the duration of the first is only that of a year, or a few months, the new circle cannot attach itself round the older. One exception to this we have in the beet, (Beta *vulgaris*), which is a biennial plant; its root, when about a year old, has from five to eight of these vascular circles. It follows, therefore, that beets produce them more then once, and they make an exception to the common rule, worthy the notice of physiologists.

§ 254.

Perennial plants, which have no bulbs, or tuberous or creeping roots, are provided with a more or less conspicuous tube of pith, round which the adducent and air vessels form a circle, which is inclosed by a very firm cellular texture, surrounded by the external integuments. Every year a new circle is added, by the number of which we can always determine their age. This is different in the creeping, tuberous and firm bulbous roots. They have, according to their species, their vessels in a circle closer to the centre, or more or less distant from it. They are annually renewed, and the old ones die. On this account we find in most of them, for a few live more than one year, only one circle.

Bulbs, consisting of scales or concentric coats, (§ 43. 1. 2. 3.), have at their base a fleshy bottom, from the extremity of which radicles and new bulbs shoot forth. This consists of a net-like plexus of vessels, which is not circular as in other roots.

Plants change their original habitation, and, in common with animals, move from one place to another. The creeping roots run forth under ground, the branch from which the new shoot arose dies, and the young root now becomes attached to a distant spot. The palmate and testicular root, (§ 11. *g*. *h*), consist, as we saw before, of two knobs, one of which completely dries up, when on the opposite side a new one is formed. This happens every year, and the plant in this way, after many years, appears on a quite different spot. Solid bulbs, (§ 43. 4.), especially the bulb of the Colchicum *autumnale*, undergo the same change; on the side of the old bulb a new one appears, the old one decays, and the whole at last becomes attached to a place, distant from that where it formerly stood *.

§ 255.

Very remarkable, and deserving particular attention is the choice of food, which has been observed in some of the creeping roots. A strawberry plant, in a garden of excellent soil, was planted in a particular spot filled with sterile sand. Stalks and roots all grew out towards the sides where the good soil was, but the main plant decayed. Several other remarkable instances are, at present, inexplicable, as we know so little of the physiology of plants.

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* The premorse root, (§ 11. 6.), is in the beginning perpendicular. After the first year the perpendicular root becomes ligneous, and on its sides new branches shoot out. The old main root must therefore decay, and it really putrifies, and owes to this particular circumstance its peculiar figure.

§ 256.

This part of the plant, then, which we know under the name *root*, however various its shape may be, has always fibres or radicles, to which alone physiologists choose to give the appellation of root. These radicles, like the leaves, are annually renewed. During spring and autumn, in cold and temperate climates, even in winter, when the whole ground is covered with snow, new ones spring in place of the old dry ones. In warm and hot climates this happens during the rainy season, therefore always at a period when the vegetable world appears to be, as it were, in a slumber. The radicles grow in the following manner: a small bundle of air vessels grows larger, pierces the cutis, and runs into the ground. It is inclosed in a delicate cellular texture, covered by a membrane and other more delicate vessels. Thus the extreme point of such a radicle is merely the end of the spiral vessels, which absorbs the necessary food from the soil, (§ 274). These fibres, which are never wanting in plants, cannot perform this function of taking up food longer than one summer, after which they must be succeeded by new ones.

§ 257.

Not all plants do grow in earth, and therefore the root does not enter the ground. The parasitic plants are an exception of this kind. The Cuscuta *europea*, dodder of thyme, when it germinates, lengthens its filiform plumule, winds round neighbouring plants, as flax, nettles, &c. and runs along them. Its rostel decays, and along the whole surface of the filiform branchy stalk a kind of warts shoot out, where it rests upon the other plants, serving as roots. Algae, but especially Lichens, are, by similar warts, attached to the trunk of trees, and few pierce their external membrane. The Sphaeriae grow mostly on the inner bark of old decayed trees; they pierce or elevate the external membrane, and are firmly attached by wart-like roots. The mistletoe, (Viscum *album*), pervades with its roots the woody part of branches, and becomes intimately blended with it. Amongst the numerous species of parasitic plants which the torrid zone produces, one species deserves notice, which grows abundantly in the Indies beyond the Ganges, the Epidendrum *flos aëris*, for it grows and blossoms in the air, when hung up. Mr Loureiro, who saw this himself, assures us, that it vegetates hung from the ceilings of rooms for years, and is uncommonly grateful to the inhabitants by the fine odour of its blossoms.

§ 258.

The root is indeed, in the strictest signification, the very plant itself. The stalks, leaves, and flowers issuing from it, are only its elongations which it makes on purpose to get proper nourishment. These may be cut off, and the root will always again throw out new elongations. The root may be divided, and each part will form a plant by itself; not so the stem, except in some ligneous plants, where the stem is merely the root elongated. Resinous or dry plants, as Pinus, Erica, Rhododendrum, are an exception to this, as in them the stem can rarely be injured, without injuring the whole plant.

§ 259.

Many experiments made by inverting plants, prove clearly the above fact. If a plumb or cherry-tree, not too thick, is with its top bent towards the ground in the autumnal season, one half of the top covered with earth, and one half of the roots carefully taken out of the earth, covered at first with moss, and then gradually left quite uncovered; if afterwards in the following year, the same is done with the rest of the top of the tree and the roots, the tree will shoot forth leaves on the branches of the root, and roots from those of its top, and in due time the root will come to blossom and bear fruit. A willow is best adapted for making this experiment in a short time, and with success.

§ 260.

We have seen, that from the rostel of the seed the root arose, and from its plumule, which is always bending uppermost, the upper part of the plant above ground, whatever its shape may be.

The stem of herbs and shrubs, as well as the trunk, the scape and the stalk, in short all the varieties of the stem, have a channel full of pith, surrounded by cellular texture, in which the reducent vessels lie. The adducent and air vessels form a circle round this, or according to the plant, a triangular, pentagonal, or hexagonal assemblage of many joined bundles, which run in a straight direction. A thin layer of cellular membrane, and another membrane full of lymphatics, incloses the whole.

The same happens in the growth of the stems of trees and shrubs during the first year. Every year a new bundle of adducent and air vessels in a circular form is added externally to the old ones. The innermost bundles of vessels are more and more compressed, till the pith at last, except where this is natural to some shrubs and trees, entirely disappears, or at least is compressed to a very small point. The interior vascular circles become annually more dense, and at last get so hard, as to form what is called wood. The less, or half indurated external circles, constitute the alburnum, and the outermost one, which is just newly formed, is now called the inner bark. This then is a circle round the stem of the tree, consisting of numerous, young, new formed vascular bundles. It commonly consists of two parts, the exterior layer changing into bark, the interior first forming the alburnum, and then the wood. The bark, in ligneous plants as well as in herbs, is green and vascular; but as soon as it grows older, its green colour changes into brown; still however the lymphatics retain their power. The more the tree advances in age, the browner and darker grows the bark; it cracks, and the function of expiration cannot go on as before, nor are the vessels in the cuticle any longer visible. Some trees and shrubs lose their bark annually, and reproduce a new one from the inner bark. As instances may be given, the Platanus *occidentalis*, and the Potentilla *fruticosa*.

The age of a tree or shrub may be easily determined by the number of these ligneous circles, upon cutting the stem through, close to the root. In the same manner the main root shews most accurately the age by its ligneous circles, when cut directly below the surface of the ground.

In the Palmae, however, according to Daubenton's observation, this is very different. For if we cut a stem horizontally through, we find no difference between an old or young tree. In them the vascular bundles don't dispose themselves in a circular form. They consist of vessels running in a straight line, without regular order, and inclosed by a cellular membrane. Nor do they grow thicker annually or possess proper bark, but this is formed by the remnants of the leaves. Daubenton is not inclined to assign the name of wood to their substance, and proposes, if it were to be given to their fibrous substance, the name of *lignum fasciculatum*, to distinguish it from the common wood, which he calls *lignum reticulatum*. As the Palmae are destitute of branches, their leaves arise not from buds, but are in fact only small separated bundles of vessels of the stem, which expand in a leafy form.

Hence

Hence it is that the under part of the petiolus remains and forms the bark.

§ 261.

If the vascular bundles of a tree or shrub remain in a straight direction, the stem ascends without sending out any branches. The new shoots in the hazel, (Corylus *Avellana*), Berberis *vulgaris* and all which the trunk of trees produce when lopped, are a proof of this. As soon, however, as the air-vessels become convoluted, and form a knot, branches are formed. By assistance of art such straight shoots may be brought to branch, by making a transverse incision through their bark. The separated air-vessels heal the lips of the wound, are several times convoluted, and growing larger are obliged to form more gems from which branches arise.

§ 262.

The growth of ligneous plants admits of five varieties:

1. Trees and shrubs, (*Arbores et frutices*), have their stems beset with leaves. On the base of each petiolus a bud or gem is formed, which again becomes a leafy branch, provided with gems of the same kind, and undergoing the same changes. If the main shoot grows at first in a straight line to a certain height without the buds on its sides being able, on account of the too hasty circulation of the sap, to form themselves into branches, or these, should they really be formed, not able to grow any more, such a plant then becomes a tree, which has a

straight and simple stem, with a branchy divided top. But if the stem divides near the root, when the sap circulates more slowly, and each bud can unfold a branch, then this plant is a shrub. By means of change of soil, place, climate, and by art, trees may be changed into shrubs, and *vice versa.*

2. Under shrubs, (*Frutices minores*), have very leafy branches, which, however, are very small, and only deposite a very delicate circle of vessels. Hence every bud attached to a petiolus is not then really evolved, as their branches are very few. They are besides, as their branches are so delicate, of short duration, and often replace their old decayed branches, by young shoots from the root.

3. The pine tribe, (*arbores accrosae*). Here we find, likewise, very leafy branches, but which on their extreme points only, and on one spot evolve several buds, of which that in the middle grows in a straight direction, the other diverging on its sides. Hence the appearance of some pines like that of a twirling stick, by which, as every year a new one is added, the age of the tree may be found.

4. Shrubby gramina, (*gramina fruticosa*), have a knotty culm, with dispersedly attached leaves. Each knot sends forth branches, but without a knot no branches appear.

5. Palmae et Lilia *frutescentia.* These have a simple stem, which has leaves only at its top; and if this is injured, the stem decays. The last sometimes retain their life by lateral branches, but with the loss of the beauty of their growth and appearance.

Besides these varieties of ligneous plants, there are many which make a transition from one to the other.

§ 263.

The Palms present the most beautiful of all ligneous stems, which kind nature has given to the warm climates exclusively. But after them, the particular growth of some trees in the West Indies, which are not of the palm tribe, deserve notice. To those belong the species Theophrasta and Spathelia. They have a simple, very high, branchless stem, which in its whole surface is ornamented with bundles of leaves. The appearance of a landscape with groupes of such trees must be very singular indeed.

A tree which grows in Africa, on the Senegal, presents the most irregular appearance, and which no doubt is the thickest tree on the globe. It is the Adansonia *digitata*. Its stem is only ten or twelve feet high, but so thick that its diameter is found to be from 25 to 30 feet. Its circumference, therefore, is from about 75 to 90 feet. Its top is very remarkable, for numerous and thick branches, of from 30 to 60 feet in length, run out from it in all directions. We ought, therefore, not to be surprised that sometimes the hollow trunk of the Adansonia is the abode of several negro families.

Not less wonderful is the tree called Rhizophora *mangle*, which bends its branches perpendicularly to the ground, and changes them into stems, so that one single tree covers the muddy rivers under the tropics of Asia, Africa and America, for more than

han a mile with a forest, consisting of numberless stems, which at the top have the appearance of a close clipped bower.

§ 264.

But there are varieties of stems, which at first sight scarcely would be counted as such; and which indeed, with regard to the structure of their vessels, are different. The whole genus Cactus with its varieties is an instance of this kind: fig. 233, represents a stem of it. The different links which commonly are taken for leaves, are parts of the stem. The leaves themselves are subulate, fleshy points, which on their base are covered with small prickles. They fall off, as soon as a bark is properly formed, and their former place is marked by the remaining bundles of prickles. The stem of some species of the genus Euphorbia, Cacalia and Stapelia, is of the same nature. The links of the stem consist of a double net-work of air and adducent vessels; the whole is surrounded by a dense, cellular texture, or a fleshy substance, and the cutis itself, has such net-works of lymphatic vessels with apertures.

§ 265.

The thorn, (§ 47), is, with regard to its anatomical structure, to be considered as a ligneous stem, and does in no respect differ from it. It arises most generally from an incompletely evolved bud which has begun to form itself, but wanting a proper supply of nourishment, remains only in form of a very short, sharp, and bare twig. It is like the woody stem of a tree or shrub, formed of the air and adducent vessels, which have grown completely hard. It therefore remains fixed, though the bark be taken off. That it arises from a want of food is easily proved by the cultivation of thorny plants. Most species of our fruit trees have thorns, but having been supplied in our gardens with extra food, they become boughs, and at last disappear entirely. Only such plants as the black thorn, which are almost covered with thorns, don't lose them entirely by that treatment, though their number is always diminished.

Nearly the same thing takes place in thorns, which are not formed from imperfectly evolved buds, but are other parts of plants, changed in their appearance. Sometimes the petioli of pinnate leaves, when they remain after the leaves have dropped off, become thorns, as in Astragalus *tragacantha*, and other species of that genus. On the peduncles they grow larger, sharper, and assume, after the flower and fruit have fallen off, the shape of thorns; for instance, Hedysarum *cornutum*: or lastly, the stipulae become sharp, ligneous, they remain and change into thorns, for instance in the Mimosa. Such changes, which frequently occur, especially in oriental plants, are generally very regular in their recurrence.

§ 266.

The prickle, (§ 48), is a prolongation of the cutis, and can therefore be taken off along with it. This consists of reticular, more or less expanded, adducent vessels, and a few air vessels, and is covered with the vascular cutis. The most careful cultivation cannot convert a prickle into a shoot, as its air vessels become very rapidly ligneous, and separate from the inner bark, and it is therefore only kept from dropping off, by the covering cutis. Prickles have sometimes a peculiar shape; they are almost of the shape of contorted tendrils in Nauclea *aculeata* and other plants. Even the stipulae of some plants are converted into prickles, for instance, Robinia *pseudacacia*, Berberis *vulgaris*, &c.

§ 267.

Tendrils have the same structure with regard to their vessels, which herbaceous stems have. They are in fact petioli without the leafy expansion, but which, having not wasted their sap in the formation of leaves, have grown longer, and on this account have become too thin and feeble to keep their straight direction. Hence arises their twisted shape. It appears, as if the diminished force of the current of air has some influence upon the tendril. For each plant that supports itself by tendrils, when distant from a wall, tree or shrub, sends out all its tendrils towards that side on which the plant is to attach itself. At least this phenomenon can scarcely be explained in any other way.

§ 268.

The pith which is found in the centre of stems, (§ 278), is a soft and spongy cellular texture, which commonly is of a remarkably splendid white colour. It is not the least different from cellular texture, and in no respect like the spinal marrow of animals. Nature seems to have provided plants with it on purpose to deposit in it a store of moisture, that they may not suffer during drought. Hence all young trees and shrubs have it, because as soon as they grow they want it no longer, the wood being an excellent substitute. On the same account we don't find it in water plants, as they very rarely suffer from drought; all of them have a hollow stem, without any pith.

§ 269.

The gem or bud is the embryo of a future branch, and its anatomy, therefore, perfectly coincides with the anatomy of the stems and leaves, as they are inclosed in it, though very minute. The period of their formation differs in different plants. In cold regions the bud is formed in autumn, covered with a great many scales, and so prepared for the mild spring. In warm and hot regions this is different; there no pernicious frost destroys the blossoms of the spring, and cold does not impair the vital power of the vegetable creation, therefore no precaution was necessary. We see then, the buds unfold themselves immediately from the bark into branches, without having remained there in the form of buds for any length of time. However, here we meet likewise with exceptions. Hot climates too, have some bud-bearing plants, as well as we in our climate possess a few shrubs, especially the Rhamnus *frangula*, which never bud. Each bud unfolds a branch with leaves, which at the base of each petiole, again produce buds. In this manner their growth continues. But this evolution of buds from buds would continue without stopping were it not so regulated, that each bud, as soon as the blossoms and fruits are perfectly formed, decays. Then the branches stop in their growth. Each bud, as plants in general in all their parts, is formed by the air-vessels. Cutting a bud in a transverse direction, a white spot appears, continued to the very extremity of the bud, which is nothing else than a bundle of air-vessels. If the same is done at an early period, an elongation of a very small bundle of the same kind is only found.

§ 270.

The leaves are composed of the same vessels of which the root, stems, and other parts of vegetables consist. But the manner in which they are disposed presents a remarkable difference. A great bundle of vessels enters the base of the leaf, and spreads on its surface in a reticular manner, anastomosing like plants, (§ 238). On this anastomosing of the vessels of leaves depends their form, and as it differs in each plant, we need not be surprised at the diversity of leaves. If the large vascular fascicle divides in three great divisions, a triangular leaf is formed; if it divides in more, then we see all the species of compound leaves arise, which we have described in the Terminology. If for instance the vascular fascicle at the base of the leaf splits into smaller ones, a nerved leaf is formed. But if it run straight forward, emitting single fascicles on its sides, then we have a veined leaf. If there are on the margins of the leaf numerous anastomoses, such a leaf is then called *folium integerrimum.* But if the fascicles spread in small unconnected branches towards the margin, the leaf becomes, according to circumstances, serrated, dentated, crenate, and so orth.

These fascicles of vessels in leaves are composed of air and adducent vessels. The net-work they form, is in both its surfaces covered with cellular texture, in which the reducent vessels lie. And the external membrane or cutis which on both sides invests the cellular texture, is provided with innumerable lymphatic vessels, (§ 235), and their exhaling pores.

The footstalk of leaves resembles in its structure that of the stem, except that the air-vessels on its base by their convolutions form a knot, which serves for the evolution of the bud, their direction having been changed. In sessile leaves, or such, which want the footstalk, we seldom find such a knot formed by vessels, and therefore they will not always produce buds at their base.

§ 271.

Of all the parts of plants, the leaves shew the most singular irritability; and particularly the compound leaves of many plants are very susceptible of stimuli. Merely by touching the leaves of Mimosa *pudica*, *sensitiva*, *casta*, Oxalis *sensitiva ;* Smithia *sensitiva* and many others, they instantly contract and fall down; if single leaves or the main footstalk be touched, they remain contracted for some minutes. Almost all triangular leaves, and leaves which are composed of several small ones, contract at night time, like the above plants, in such a manner that one leaf covers the other, and the whole becomes, as it were, compressed. Whoever will take the trouble to examine the plants of a garden at night-time with a lantern in his hand, will find several of them in this state, which has been compared to sleep, (§ 7). There are plants which, at a certain hour in the day, open and close their leaves. Du Hamel made experiments with the Mimosa *sensitiva*, which at a certain hour in the evening shuts its leaves, and again at a certain time opens them in the morning. He put this plant in a leathern trunk, covered with woollen blankets, and found that its leaves opened at a certain hour in the morning, and again were shut up in the evening. It has been alleged, that this phenomenon varies in its period, when going on in vacuo.

A plant which grows in the marshes of South Carolina, known under the name of Dionoea *Muscipula* has a singularly constructed leaf. At the apex of a lanceolate leaf an elongation is seen armed with short prickles, which as soon as an insect or other small body is put upon it, shuts itself, and does not open, till the body caught by it becomes quiet.

The species of Drosera *rotundifolia* and *longifolia*, the leaves of which are provided on their margins and surfaces with petioled glands, contract, according to Roth's observations, when stimulated, though very slowly.

A species of filix in North America, the Onoclea *sensibilis*, has got this appellation merely from the circumstance, that its young leaves, when they begin to unfold themselves, shrink upon the least touch. The Nepenthes *distillatoria*, growing in Ceylon, has on the apex of its leaves a leaf-like *ascidium*, (§ 33), of which fig. 28 is a representation, which at times opens and closes, and even is filled with water.

Of all plants, however, in that respect, the most singular is the Hedysarum *gyrans*, growing on the banks of the Ganges. It has trifoliate leaves, of which the central one is larger than the two others. All these leaves move spontaneously. The large one rises backward up and down, the two smaller leaves at the sides have the same movement, only somewhat stronger. Laying hold of these leaves, and then removing the hand, quickens their motions, as if they were to make up for the lost time, till at last they return to their former slower motion. No particular stimulus seems to act on them, and they do not contract like other irritable plants. Nor does this motion of the leaves depend on sun light, for they move in light as well as in the dark, even when the leaves are perfectly asleep. It is besides remarkable, that the leaves in the height of erection, and during very warm but serene days, like the animal muscular fibre, shew a tremulous motion.

§ 272.

That plants transpire, has been said before, (§ 239), and that the leaves, as well as the stems and branches of trees, which are provided with the apertures before described, (§ 236), serve these functions, experience teaches us. Bonnet covered leaves with oil, and found that they grew black and decayed.

Most of the philosophers, who have made experiments on this part of vegetable Physiology agree, that it is the upper surface of the leaf chiefly which performs the transpiration. However, it seems not yet decidedly proved, whether there is not in various plants some difference in that respect, and whether or not both surfaces sometimes equally transpire?

In young leaves we often see the transpired matter hang in form of small drops. A young plant of poppy, (Papaver *somniferum*), as well as young wheat, has, after cool nights, always a drop of moisture hanging on the points of its leaves, which disappears in day time, and in vain is looked for in the grown plant. Arum *macrorhizon* shews the same on its young leaves in our hot-houses. A new simple leaved species of the Mimosa from New Holland, has on the base of each leaf on its upper surface such drops. The Hibiscus *abelmoschus* has, on the under surface of its leaves, a great quantity of drops.

§ 273.

Besides the moisture which the parts of vegetables, especially their leaves transpire, they likewise give out gases. This respiratory process, as it may be called, of plants, was first discovered by Bonnet in the year 1754; after him more accurately observed by Priestley in 1773, who was followed in 1779 by Ingenhouss, and soon by many other celebrated chymists, of which we shall only mention Sennebier, Scheele, Achard, Sherer and Succow. No branch of the Physiology of plants has been examined with more numerous experiments. We shall not at present repeat all those, which confirm the phenomenon of transpiration in vegetables, and which throw new light on the whole Physiology of the vegetable kingdom; the various results will suffice, which are to be deduced from such minute and careful experiments.

Plants in general, but particularly their leaves, emit oxygen gas, when exposed to the sunshine; at night time, however, during darkness, they exhale carbonic acid gas. At sunshine the pine-tribe, the gramina, and many of the succulent plants, exhale a vast quantity of oxygen gas. The leaves of trees emit less of it than herbs. No oxygen gas whatever, even when exposed to the sun, is exhaled by Ilex *aquifolium;* Prunus *laurocerasus;* Mimosa *sensitiva*, Acer *foliis variegatis*, the petala, ripe fruits, the bark of trees, the footstalks or the fibres of leaves. The gas which is emitted during night is by far less in quantity, and not in all plants pure carbonic acid gas, but often mixed with azote and hydrogen. It is scarcely necessary to remark, that in the great number of plants the modifications of these gases are various.

§ 274.

From all those circumstances together, which we have hitherto explained, compared with the observations which we intend still to make, we are enabled to make some general conclusions with regard to plants. The air-vessels, (§ 235), no doubt perform the most important functions in plants. Their wonderful structure alone, (fig. 282), were we not to attend, to what we have said of them in the preceding page, would lead us to conclude, that they must be destined to answer very important purposes. Nobody, however, has as yet offered a decided opinion with regard to their operations. We shall therefore now make an attempt to explain their use.

That vegetables have life, was proved, (§ 224, 226), before. If we now compare this vegetable life with that of animals, we will, sensation excepted, find very little difference. We observe that animals are provided with one or more apertures, by which they inhale air, and without which life ceases. We find that they take in food by one aperture, which food, according to the difference of animals, must pass through variously-shaped canals; that they prepare from it those particles which are fit to support life, and which are assimilated by the vital power. Further, we see that the remnants of the alimentary mass, as soon as they cease to contain any thing serviceable for the machine, are thrown out. No animal can subsist without those processes, none grow and thrive. Does not, therefore, nature follow a similar plan in vegetables, which, as we know, take in food, and exhale gaseous fluids? Were we quite strangers to the structure of the organs and vessels in the vegetable kingdom, we might however be able to draw that conclusion *a priori*. But we know their structure, and need not form hypotheses, as we are acquainted with the nature of the air-vessels. They act, at the same time, as the trachea and as the intestines of plants. The radicles or fibres of the roots, consist almost entirely of air-vessels. They imbibe, with their spirally winding channels, the necessary moisture. The hollow air-vessels carry carbonic acid gas, which has become free, through caloric as well as oxygen gas. They convey the whole to the root. The vital power fixes the carbon, and decomposes the water, (§ 278).

The chief food of plants consists of carbon and hydrogen. The hollow air-vessels carry the oxygen gas, which was formed during the day, out of the plant, and at night time, when the rays of the sun are wanting to evolve more oxygen gas, they exhale, through the pores of the cutis, carbonic acid gas, which they received from the ground, and which, for want of light, they could not keep fixed. The more convoluted vessels, by means of those convolutions, prepare, by aid of light, the secreted juices, and carry the rest, in form of thin vapours, off through the pores of the cutis. These apertures or pores, which have valves, by which they may close and shut themselves, are certainly the ends of the air-vessels; at least we may suppose this with certainty almost, though ocular demonstration is still wanting. Those juices which are salutary and ready prepared, are now deposited in the cellular texture, from which, most probably, the rest of the vessels receive them. The air-vessels, besides, inhale atmospheric air, and the different matters dissolved in it, and decompose it into the necessary carbon and other constituent parts, by means of the light and vital power, to prepare them in the same way as those taken up by the root.

These air vessels, therefore, were we to compare them to the organs of the animal body, serve as lungs, mouth, stomach, mesentery and anus.

§ 275.

The excrements of plants are not so considerable or conspicuous as those of most animals, as their food consists of water and air only. They cannot, therefore, emit the superfluous matter which is of no further service to them, under any form, but that of air. Their transpiration, (§ 239), and the gaseous fluids which they exhale, (§ 273), prove this clearly. Mr Brugmanns, however, asserts even in them to have observed a particular excrementitious matter, which deserves farther notice. He saw in some luxuriant plants which he had in a glass vessel filled with earth, that during night there appeared on their radicles a drop of moisture, and observed distinctly, that when such a drop came in contact with the radicles of other plants not so luxuriant, the last soon became dry. If this happened repeatedly, the plant decayed. He says he found that, Oats, (Avena *sativa*), was killed in this manner by Serratula *arvensis*.

Flax, (Linum *usitatissimum*), by the Scabiosa *arvensis* and Euphorbia *peplus*.

Wheat, (Triticum *aestivum*), by Erigeron *acre*.

Buck-wheat, (Polygonum *fagopyrum*), by Spergula *arvensis*.

Carrots, (Daucus *carota*), by the Inula *Helenium*, and that the different weeds, as they are called, hinder thus the growth of the above plants. From this observation, if it should be confirmed by further researches, the antipathy of different plants might be explained. But might not the growing of the one and the death of the other be explained upon the simple principle, that, as weeds consume the same food with cultivated plants, the first perhaps take up the nourishing matter with a greater velocity? This remains still to be determined.

§ 276.

The nature of the circulation of sap in plants, is at present still involved in great obscurity. In our times nobody, I suppose, will choose to maintain with with Jampert, mathematically, that plants have no vessels, as Grew, Malpighi, Muftel, Moldenhawer and Hedwig have stated and proved their presence long ago, and even ocular inspection may convince all remaining sceptics of this truth. Notwithstanding, however, we are still ignorant of the manner in which the sap passes through these channels. Dr Hales ascribes the ascent of the sap to the rarification of air and capillary attraction. Some allege, that the sap ascends during warm weather, but descends again when cold supervenes. Others only allow the ascent of the sap and its transpiration through the pores of the cutis, but deny its descent or reflux, as this, they believe, would hurt the structure of the plant.

Malpighi was the first who ascribed irritability to the smaller vessels, and supposed that they were sometimes contracted, sometimes dilated in diameter. This philosopher even asserts, that in one of the air vessels he actually observed a peristaltic motion of its spiral windings, similar to that of the animal intestines. But was he not deceived by the elasticity of the twisted vessels, which to see them distinctly must be separated?

Brugmanns confirmed this irritability of plants which Malpighi only suspected, by a series of elegant experiments. Branches of the Euphorbia *lathyris* and *myrsinites*, when cut off, discharged a considerable quantity of milk-like fluid out of their vessels. This haemorrhage he stopped immediately by a solution of alum and sulphat of iron, which was so diluted as not in the least to stain paper or linen. The stoppage of the flow of the juice is certainly to be ascribed only to the solution of the alum and sulphat of iron, contracting the apertures of the vessels. Van Marum repeated this experiment, but without the same result. It is indeed put beyond doubt, that the propulsion of the sap depends on the peculiar contraction and dilatation of the vessels, not on capillary attraction, nor on the rarification of the air by means of the solar rays. Even Bonnet himself, who at first adhered strictly to Hales's opinion, found himself induced by Van Marum's observations, to change it, and to admit the irritability of the vessels, as the sole cause of the circulation of the sap in them.

If we now contemplate the vegetable world with attention, and accurately observe this phenomenon in it, we will no longer doubt, provided a concluſion from analogy be allowed, that in plants as well as in animals, a real circulation of the sap takes place, not a mere ascent and descent of it. Still, however, nobody has yet proved it, and few indeed have even with Malpighi and others ventured to admit it But is it possible, that through a mere ascent and descent of the sap, the leafless tree is able to resist the cold, if there be not a circulation of the sap? A stoppage of the motion of the sap, or a constant descent of it during cold, certainly cannot be maintained; it is even contradicted by experience. If we admit the first, then the sap of a tree would congeal without injury during winter. Now we know, which happens especially with delicate exotic plants, that by a sudden invasion of intense cold the sap congeals, and the plant, at least most of its parts, are lost. If, on the contrary, we believe that the sap in winter is constantly descending, whence proceeds all the moisture during this long period, especially as the temperature is so low that even a delicate leaf cannot subsist? There must be a circulation, of whatever nature it be.

We have not yet found in vegetables one point, like the heart of animals, from which the motion of the sap commences. But it does not follow, that no circulation is possible. What we suspect at present, the labours of philosophers in some future period will, it is to be hoped, establish as a truth. Perhaps this point, from which in vegetables the sap seems to ascend and descend, is only to be sought, where the parts above and below ground take their rise.

The experiment mentioned before, (§ 259), to invert a tree, and to change its roots into its top, and the reverse, has commonly been adduced as a proof of the ascent and descent of the sap. It has even been alleged, that by this means those channels which carry the sap upwards, are forced to send it downwards in their new position. But in making this objection, it seems to have been forgotten, that the sap must likewise circulate in the root, which not only sends it forth to the stem, but in summer grows itself larger, in the same proportion as the stem does: that Grew found the air vessels winding in the root in a different direction from the stem, (§ 235), and that we are not entitled to conclude that in an inverted plant the same vessels must carry the sap in a reverse direction. It is not the same thing to invert an animal, and to put it upon its head, and to invert a plant. The one will not remain long in this situation without being materially hurt, whilst the other will not suffer from it.

§ 277.

What has been always adduced as another proof of the ascent and descent of the sap in plants, is the important, but altogether mistaken phenomenon, that after the middle of January, with us after the 20th, the sap enters trees. At this period it is thought to descend, to be ready in the spring. But whoever thinks that trees, shrubs or herbs are, as it were, dead in winter, and without action, is much mistaken. I shall endeavour to refute this opinion, and to represent this fact in the way it ought to be considered.

During the whole summer the root sends the food which it has imbibed by its radicles to the stem, and what the stem receives from the leaves is constantly wasted in the formation of new parts, till either this evolution ceases, from the strength being exhausted, as in annual plants, or till the parts above ground, which can no longer resist the inclemency of the weather, become separated, as in herbs, shrubs and trees. With the fall of the leaves in ligneous plants, and with the drying of the stem in herbs, all their vegetating powers are exhausted. The great quantity of moisture which the root forwarded to the plant, is consumed, in trees and shrubs, in the formation of branches, of wood, splint, inner bark, leaves, blossoms and fruit, as well as in the growth of the root: in herbs, in the formation of the parts above ground, the fruit and the root itself. These fibres, which hitherto conveyed the food, begin to become harder, and are no longer able to serve this purpose. The sap which circulates in the vessels can no longer produce new shoots above ground, as the temperature is unfavourable. From the moment, then, that the leaves of ligneous plants and the stems of herbs decay, the plant begins to form new radicles in place of the old ones. If at this period, in the latter part of autumn till the middle of January in our climates, a birch or walnut is bored, we get no sap. The tree has sap, but only as much as it just wants, and as suffices to form new radicles. Hence fruit-trees, which had too much fruit, decay, because their strength by the too great waste of sap is exhausted If such a tree or shrub has formed radicles, before the middle of January, those active young radicles perform their new functions. They imbibe moisture, which they deposite in the cellular texture, and collect in this manner as much sap, as the wasting of it by the vegetable powers, which in the next summer season are required, makes necessary. If at this time a stem is bored, a great quantity of moisture flows out, in those plants which receive a great quantity of it. But if at the end of January or February, the weather becomes mild, this flow of sap ceases altogether, and trees when only then bored, give no sap. This flows again when the weather becomes cold. Those who adhere to the theory of the ascent and descent of the sap, say, that in warm weather the sap ascended too high, and in cold descended too low. This singular change, however, of its flowing and ceasing to flow, depends on this, that as soon as the weather is fine and mild, the transpiration in plants goes on with greater rapidity, therefore naturally the quantity of the sap becomes less; on the contrary, in cold weather the transpiration is not considerable, and therefore the sap accumulates.

On this account we find, that the roots of herbaceous plants which we collect for medicinal purposes, are more efficacious in winter and spring, than in summer, when in full leaf and flower, because then they have prepared new sap by their young radicles.

§ 278.

That plants emit oxygen in day-light, and in the dark principally carbonic acid gas, has been already mentioned, (§ 273). The reason of this, as the latest discoveries in chemistry have shewn, we are now to explain.

Plants imbibe through the pores of the cutis, (§ 274), atmospheric air, which consists of azote, oxygen, and carbonic acid gas; the azote being the greatest in quantity, the carbonic acid gas the least. Experiments prove this phenomenon clearly. Plants which were put in carbonic acid gas, soon decayed, as well as when inclosed in azote and hydrogen gas, with this difference only, that in the two last gases they decayed slower. The cause of their decay is certainly no other, but that they want the necessary oxygen in the inclosed air, and their vessels therefore become relaxed.

From the ground, plants imbibe water and carbonic acid gas, (§ 274), as well as oxygen. We know, that the carbonic acid gas is specifically heavier then the other gases, that it precipitates and is absorbed by water, and that on this account it is easily taken up by the radicles of plants. For this very reason Sennebier alleges, that plants grow so very rapidly after a thunder storm with rain, as this last contains much carbonic acid gas. On this point, however, the opinions of philosophers are very contradictory, for many of them deny that a greater quantity of carbonic acid gas exists in rain during a thunder storm. That vegetables imbibe oxygen from the ground, seems to be confirmed by the observation communicated to me by my often mentioned friend Mr Humboldt, in a letter dated May 1st, 1798. The following are his words: "If I took "400 parts of atmospheric air, of a known quality, "for instance, 28 parts of oxygen, and brought "it in contact with mould, (*humus*), or loam; "from 50 to 70 parts disappeared, but scarcely 3 "or 5 parts of carbonic acid were given out, and "the rest of the inclosed air contained hardly 12 "or 14 parts of oxygen. The ground therefore "imbibes oxygen in a solid form from the atmo-"sphere. The oxygen combines, I believe, with "the hydrogen and carbon of the humus, and the "product is an oxyd of hydrogen and carbon, "which has not yet formed water or carbonic acid. "This light compound is easily taken up by the "vegetable fibre." From this we might be able to explain, why oxygen, as we shall find presently, is indispensably necessary for the vegetable fibre and stimulates it to growth, (§ 251). Hence plants grow better in newly dug garden earth; and trees planted in holes, which were during the whole winter exposed to the influence of the open air, thrive better than when planted in long used earth, or in ground covered with turf.

The rays of the sun conjoined with the vital power of plants promote the decomposition of the water in its constituent parts, hydrogen and oxygen. The oxygen stimulates the air vessels, and even by stimulating the vegetable fibre in general, quickens all the secreting processes. It combines besides with caloric, and escapes in a gaseous form through the pores of the plant. The imbibed atmospherical air is, through the increased stimulus of the vital power, freed from its carbonic acid and azotic gas. In the same manner the carbonic acid gas of the water, which was taken up by the roots, and which, even perhaps itself is imbibed by them in its gaseous form from the ground, becomes fixed. These matters now enter, according to the assimilating power which is inherent in each plant, and which appears to be a modification of the vital power itself, in different new combinations and in different proportions, forming oils, resins and gums, and all the rest of the above enumerated (§ 230), vegetable principles.

In darkness, however, when the light no longer rouses the vital power to the decomposition of the water, the oxygen contained in the atmosphere again forms new and different combinations with the other principles. It cannot now stimulate the vessels, and therefore a small quantity of gas is emitted by the plant. The quantity of the carbonic acid gas cannot become fixed, and therefore again parts with the plant as such.

The light of the sun effects, even in aquatic plants, at the bottom of rivers and brooks, the decomposition

tion of water. Conferva *rivularis*, when exposed in a glass vessel to the rays of the sun, constantly evolves new shoots. Trees likewise shew how beneficial for them the influence of light is, as they all grow thicker and fuller of leaves towards the south.

The same stimulus which the oxygen gas in sunshine offers to the vegetable fibre, likewise produces in it the state of sleep. After constant application of stimuli, relaxation must necessarily follow, of which the consequence is, that in the evening the leaves become folded up. For the very same reason some plants fold and unfold their leaves at certain hours. Du Hamel's experiment, mentioned above, with the plant, which he put into a trunk, might perhaps be explained in this way. The leaves could not but open in the morning, after they had during night imbibed moisture enough to resist the new stimulus; but how did it happen that they shut again in the darkness of a certain hour, when no light could effect the decomposition of water? Du Hamel did not make the experiment with sufficient accuracy, for he did not examine the state of the air, in which the plant in the trunk was placed. Had there been hydrogen gas in it, the experiment could be easily explained, as this gas acts in the same manner upon plants as light does.

The oxygen gas, if accumulated to a great degree, makes leaves and all parts of vegetables pale and even white.

Hence it is, that plants in the dark, when the gas cannot be evolved by light, grow whitish.

Mr Humboldt found that the leaves of the Lepidium *sativum*, in the faint glimmer of a lamp, which was kept up for some days, retained their green colour. I saw myself this singular and remarkable phenomenon.

Hydrogen gas likewise promotes the decomposition of water in vegetables. Sennebier and Ingenhouss observed that plants, inclosed in hydrogen gas, transpired day and night oxygen gas. Mr Humboldt on the 14th February 1792 took a germinating bulb of the Crocus *vernus* down to one of the celebrated mines of Freyberg, and planted it in the ground. In its galleries the air was so much contaminated with hydrogen gas, that his candle went out, and his lungs became sensibly affected. The germ of the bulb soon evolved its leaves and flowers. Till the 17th day the leaves were green, the flowers yellow, and the anthers even full of pollen; but on this day the whole plant began to putrify. Several plants shewed the same result. The hydrogen gas cannot however be considered as a stimulus of vegetables, as in its pure state it kills plants, and only when mixed with oxygen shews the above phenomena. Plants therefore remain alive in it as long only, as they can still exhale oxygen; when this stops the plant is gone.

Oxygen gas is therefore, as experience shews, as exclusively necessary to the subsistence of plants as of animals. Its stimulus of the vegetable fibre is that which preserves the health of plants; and therefore plants grow rapidly when they can imbibe oxygen gas from the ground. Seeds likewise

wise germinate sooner when stimulated with this gas. Mr Barton however discovered another great stimulus of plants, on which philosophers should make still further experiments. He found that in water in which camphor was diffused, a decayed twig rapidly recovered, which did not happen when it was placed in common water. A decayed branch of Liriodendron *tulipifera* and a withered flower of the yellow Iris recovered in it and remained long fresh. I myself tried this with a branch of Silene *pendula*, the flowers of which were quite shrivelled; in an hour's time I found the petals again perfectly expanded, as if just evolved. Is it the hydrogen of the Camphor which stimulates the vegetable fibre to such a degree, as to produce this phenomenon? or is it a consequence of the composition of the camphor, the carbon being mixed with the hydrogen in such a proportion which alone can act as a stimulus on plants? This remains to be determined.

Light likewise is a very powerful stimulus of the vegetable fibre. Every body knows that hot-house plants incline their stalks and leaves always towards the windows. A plant which has been confined for days in a dark room will, as soon as some light is admitted, however small the aperture be through which it passes, bend its stalks towards the light. Who does not know, that the species of Lupinus, especially Lupinus *luteus*, turn in the open air their leaves and stalks towards the sun, and follow its course in so steady a manner, as to enable us to specify the hour of the day from their direction?

Barton found, that a solution of nitrat of potass had just the opposite effect. A few grains of it killed the Kalmia. Mr Brugmans, on the contrary, asserts, that nitrat of potass is an excellent stimulant to make vegetables grow. It is said that the Dutch gardeners make bulbs of Hyacinths, Narcissuses, and others, grow earlier by an addition of nitre. Tromsdorff likewise found, that a sprig of the Mentha *piperita* became 378 grains heavier in a solution of nitre, whereas another sprig in common water, gained only 145 grains in weight.

There is no doubt, that the decomposition of the water produces at the same time the peculiar temperature of plants, (§ 240). But the manner in which cold originates in them, has not yet been established. Sennebier and Hassenfratz believe, that as plants grow by decomposing the water, and combining the oxygen and carbon; the oxygen which thus becomes free, combines with the caloric of the vegetable fibre, goes off in a gaseous form, and produces the low temperature of plants. Mr Humboldt thinks, that plants take up caloric from the atmosphere, and with it give to the oxygen, which the light has separated, its gaseous form. From this he explains the great coolness under the shadow of trees.

That in the Fungi the process of inhalation and the separation of gases follow other laws, is certain. But we are so little acquainted with the nature of these vegetables, that we have not been able to fix those laws. Agaricus *campestris* and *androsaceus* constantly exhale oxygen gas, and perhaps most of them do it. They seem, however, likewise to require the stimulus of the oxygen of the atmosphere, as inclosed in hydrogen and azotic gas most of them decay rapidly. All plants, however, do not bear the stimulus of light and oxygen equally well, Each stimulus must be in proportion to the vegetable fibre, and when too strong it acts in the contrary way, and destroys it. All subterraneous plants, as was found by Scopoli and Humboldt, decayed in atmospheric air. And in summer all the species of Boletus, which grow in cellars, suffer from the access of atmospheric air. Daily experience indeed proves this, as rooms and chambers which are damp and mouldy, are soon freed from this nuisance when air is freely admitted. So strong is the stimulus of the little oxygen of the common atmospheric air to those plants, that they suffer from it and perish.

Though a moderate degree of light and warmth favours vegetation, too great a heat is uncommonly noxious. The burning rays of the sun debilitate plants too much, and impair their irritability by the relaxing power of heat. Mimosa *pudica* loses almost entirely its irritability by a long continued heat, and the leaves of Hedysarum *gyrans* cease to move. Grown up leafy plants during sultry days resist the rays of the sun, though entirely exposed to them, better than young germinating plants. In the shade, and in milder light, plants germinate most successfully. Thus nature has carefully provided for the small delicate plants, which grow in the shadow of the larger ones. Every gardener and forester knows this, and he can only hope for success in his art, by attending to this provision of nature*.

§ 279.

What vegetables imbibe from the atmosphere is not inconsiderable. All succulent plants grow in dry places, and in general the most succulent plants of the globe, are found in the most barren and arid spots. The Karro fields of the Cape of Good Hope, where it rains a few weeks only in winter, but is hot and dry during summer, are adorned with numberless succulent plants, which can imbibe nothing from the ground, but are always full of juice, and grow well. Can those plants receive their food from any other source but the atmosphere? We find even that they suffer in our gardens from moisture, and soon become rotten, whereas they grow well, when little or not at all supplied with water.

Rain, besides the above mentioned use, to moisten the ground, furnishes plants with water for decomposition and keeps their pores open, and fit for the transpiration of gases. In very dry weather, we will find with a microscope most of the pores filled with dust. If the drought continues long, and the dust is accumulated, then the leaves fade away, because they can no longer perform their offices. A species of maple, the Acer *platanoides*, suffers most and soonest from drought, and I have seen its leaves on this account often drop off very early.

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* Opium is said to affect the irritability of plants materially, nay even to destroy it entirely.

That plants imbibe the moisture of the atmosphere and rain, is proved by a very simple experiment made by Bonnet. He placed a leaf of the white mulberry-tree, Morus *alba*, with its upper surface upon water, and it remained six days fresh and green. Another leaf of the same tree, laid with its under surface upon water, remained six months fresh. This I think shews, that plants rapidly imbibe by the under surface of their leaves the dew of the night and the moisture of the atmosphere.

This office is performed by hairs or pubescent points, which are on the surfaces of plants. The under surface is therefore never quite without them, and in many plants this hair is a hollow tube constructed for that purpose. When leaves have no such pubescence, small apertures are found in their place.

§ 280.

Carbon and hydrogen are the substances of which the food of plants chiefly consists, and they therefore form the two chief constituent parts of vegetables. By various organs and glandular bodies they are, according to the power of assimilation, combined with other substances, and changed in form and appearance, so that different parts have likewise a quite different smell or taste from others. The roots, for instance, of Mimosa *nilotica*, smell like gum asafoetida; the sap of the stem is of a very sour, astringent taste, the well known gum arabic exudes from it, and the flowers possess a very sweet smell.

In this respect, therefore, plants likewise resemble animals, as in the animal, juices are secreted of very different properties, taste and smell. In both kingdoms, however, the manner in which this is done has not yet been explained by physiologists. That the secretion and assimilation of the different fluids depends on the vital power is certain, but whether the attraction of the minute particles, or their mere form and shape deserve most attention, is not yet known. In the old vessels the irritability is less than in young ones, in the last therefore more earthy particles are deposited, the sap is sooner concreted, and, as they grow in years, they become harder and harder. Hence it is that these inner vascular circles grow more dense, and form the wood (§ 261). Those trees in which most carbon is fixed, acquire a harder wood, and will therefore grow slower than others. Some species of beech, Carpinus *betulus*, and Fagus *sylvatica;* the oak tree, Quercus *robur* and *pedunculata;* the Pinus *cedrus*, Adansonia *digitata*, and other trees, will serve as instances. But even here we have some exceptions; I will only mention the Robinia *pseudacacia*, which fixes a great deal of carbon, and in a short time has very hard wood. Each organized body, whether animal or plant, has been endowed by nature with a peculiar degree of vital power, which we cannot estimate, and its organization is such, that by an equal supply of food, each makes different combinations, depending on this unknown power.

In a plant, therefore, vegetation goes on according to the modifications of the vital power, in the following manner: The root takes up moisture and a small quantity of gas from the ground, and carries them, properly digested, to the stem. This, as long as green, inhales air and particles dissolved in it, and variously prepares it in its vessels. The leaves imbibe air and moisture, and again transpire gaseous fluids and moisture, and carry what they have prepared from those principles to the young bud, or the evolving part of the plant, as its food. That buds are nourished by means of the leaves needs no further proof than that in tender twigs, if we take off the leaves at the time when they ought to nourish the buds, these last cease to grow and to unfold themselves. If the leaves are taken off from branches which are already ligneous, they may be restored by the accumulated quantity of sap in the cellular texture.

The sap of plants we know, (§ 237), has some likeness to the blood of animals. Plants collect a great quantity of it, to be provided against all possible accidents. Bulbs take up much sap, and with it form, at the time of flowering, all necessary parts. Du Hamel with Grew calls the sap of plants cambium. He could perceive no connexion betwixt the wood and the bark of a willow-tree, but found there a fluid, which became in the open air gelatinous and tenacious. He deprived a cherry-tree the whole length of its stem of the bark, when it was in full blossom, and covered it with a thick layer of straw; the tree bore no fruit, lost many of its leaves, and even some boughs. The next year it had not yet recovered, but in the third a new bark was formed from the sap or cambium. This sap it is, therefore, which causes the formation of the vessels and their fascicles. It is most plentiful where the youngest layers of vessels in the stem lie, that is in the inner bark. The wood which was formed from the outer bark becoming hard, has the sap not in so great a quantity. The vessels of the wood are in general less active, they carry therefore less fluids, and those but slowly. The inner bark, on the contrary, which possesses still young and active vessels, is the only part in the plant possessed of life, it can therefore make with its air vessels the most use of the sap. If then the inner bark is injured or wounded in a ligneous plant, so that the air has free access to it, the plant dies. The extremities of the vessels in the inner bark shrink together, and the sap alone has no power, it dries up entirely. In hard winters those trees have often been seen to die, which had their inner bark frozen, where those, whose pith and wood only were affected by the frost, not the inner bark, grew as formerly. From this observation we are entitled to conclude, that the life and duration of a tree or shrub, depends entirely on the health and activity of the inner bark.

Every tree or shrub with us sends forth annually a large and a small shoot. The first and principal shoot appears in spring, the last on the contrary, about St John's day, near the longest day in June. Hence the first has been styled the spring shoot, the other the St John's shoot. Under the equator and the tropics, each shoot is in most plants of equal size, and the growth of plants for this reason in the torrid zone is very great. The second, or St John's shoot is, properly speaking, only a continuation of the first. The first shoot is pushed forward by the old stock of sap which had been collected, the second, by the sap which is still forming during favourable weather.

§ 281.

The green colour with which all the vegetable creation is invested, is a most cheerful sight, and it is but natural to suppose, that the investigation of its cause has always and long ago attracted the attention of philosophers, and given rise to many hypotheses. When phlogiston still had a number of adherents, the explanation of the green colour was very easy, it was considered as an effect of this principle. Since, however, the idea of its existence has been given up, different ways of explaining the nature of this green colour have been devised. We shall not at present enumerate them all, but merely notice the opinions and observations of late philosophers. Berthollet says, that the green of plants does not consist of blue and yellow, as the prism does not separate their green, like that of other bodies, into yellow and blue rays.

After extracting with alcohol the green colour from the leaves, and exposing this mixture to the sun or atmosphere, the green colour disappears entirely. The oxygen of the atmosphere combines with the mixture, and banishes the colour. If a solution of ammonia, which consists of hydrogen and azote, be dropped into it, the oxygen parts with the mixture, and the green colour is restored to it. Almost all known observations on this point prove, that leaves, which have parted with their oxygen by means of light, are green, but get a pale or whitish colour where the oxygen is accumulated. Chemists now mostly assign as a cause of the green colour of plants, the particular proportion in which the hydrogen and carbon are mixed.

§ 282.

The dark colour of the bark in woody plants is, according to Berthollet's observations, produced by the oxygen of the atmosphere. Mr Humboldt repeated his experiments, and found that wood, when inclosed in oxygen gas, became black in two or three days, and the gas was mixed with carbon. It appears from this, that the oxygen of the atmosphere combines with the hydrogen of the vegetable fibre, and sets the carbon free, which shows its particular black colour.

§ 283.

The duration of the leaves of plants varies very much. Most of them in warm climates remain from three to six years on the stem. A few in colder climates, and only those which have a tenacious sap, as Ilex *aquifolium* and Viscum *album*, or such, which have sap of a resinous nature, as all the pine-tribe trees, retain their leaves during winter. All other plants of the colder climates drop their leaves in autumn. This happens in many different ways. Some leaves shrink gradually together, fall off, or remain on the stem in a dry state till spring; others fall off when still green, and in the still milder days of autumn. In quite a different manner the Robinia *pseudacacia* parts with its leaves. The pinnate leaves of this tree first drop all the pinnulæ, and at last, after them the petiole to which they adhered drops off.

Various reasons have been given by authors, why plants lose their leaves in autumn, and we shall now consider their various opinions on the subject.

Du Hamel formed two hypotheses. He assumed, in the first place, a herbaceous part in the petiole, at the spot where its notch is, which in cold autumnal nights becomes injured, and produces the falling off of the leaves.

He abandoned however this opinion, because he saw leaves drop off in warm autumnal days, without any preceding cold, and then produced the following explanation. The moisture, which is conveyed to the plant by its roots, favours the growth of the petiole, the great transpiration of the leaves renders it at last quite dry, and therefore the leaves fall off, because the petiole has lost all its sap.

Mr Mustel thought that the leaves transpire less during autumn. Hence the sap is accumulated in them, which produces a transverse fissure at their basis. The leaves, therefore, become separated from the petiole, and drop off.

Vrolick believes that leaves possess a peculiar life, in which various periods may be distinctly marked. Their life, however, depends entirely on the life of the plant. When they fall off, they have come to their greatest age, and the plant can exist for some time without them. The dead leaves separate from the living part, like dead parts in the animal economy from sound ones.

Were the opinions of Du Hamel and Mustel founded in truth, the leaves would never fall off in warm climates. But there are in the East Indies some trees which, at the rainy season, drop all their leaves, and like our trees, are perfectly leafless. Mr Thunberg likewise saw at Java an oak tree which lost its leaves at the same time as in Europe. There must therefore exist another cause of this phenomenon. Vrolick's opinion is just, and perfectly corresponds with all observations.

The true cause of the falling off of the leaves is this: During the summer, the vessels of the petiole become gradually ligneous, as the sap is conveyed to them in greater quantity, and the whole frame of the leaves gets a more ligneous consistence. The sap must in consequence stagnate, and at last the communicating substances between the stem and the petiole are completely dried up and crack. The wound which the stem thus receives cicatrizes before the petiole separates. The connexion now interrupted between the leaf and the stem, and their vessels, causes the petiole, by which they are connected, to separate entirely, and thus, in calm serene weather especially, the leaves unavoidably fall off. Besides, the rays of the sun still favour the last decomposition of the water, but the reducent vessels cannot convey the small quantity of moisture to the knot of the petiole. Now, though this quantity of sap is very inconsiderable, yet its motion naturally will cause some sort of concussion, which perhaps is alone sufficient to make the leaves finally fall off.

In the oak tree the leaves cannot fall off in autumn, as the vascular fibre of this tree is very tough, and on this account the connexion between the knot of the petiole and the stem is not broken. In the Robinia *pseudacacia* the small and tender petioles of its leaves first get closed up by the sap, and separate of course earlier from the common petiole, which is still succulent enough to remain a short time, but soon, as without the leaves it cannot subsist, has the same fate. It depends therefore entirely on the nature of the leaf, how long it is to remain on the stem, not on the weather. Besides, the natural organization must be attended to, as it has a powerful influence.

§ 284.

The growth of the plant ends with the evolution of the flower. When a plant has acquired a certain degree of firmness, (which, as they are so multifarious, does not happen in each at the same time, or at the same age), it then becomes capable of propagating its own species, and that part which we know under the name of the flower, is now formed. Its beginning, or the quickly expected final evolution, in herbaceous plants, may generally be observed from the circumstance, that the minute scaly leaves grow gradually less, till the smaller and more delicate parts of the flower are at last unfolded. Goethe is therefore not quite mistaken, when he compares the growth of plants to a contraction and expansion; an idea which Wolf already has endeavoured to prove.

§ 285.

The flower is likewise, as all the other parts of plants, formed from air vessels, which, as soon as the first rude sketch, as it were, of the flower exists, are already observable. Linné's opinion with regard to the formation of the flower, is quite erroneous. He considered the pith of a plant, which he believed to be of equal importance with the spinal marrow of animals, as the sole formative organ in the whole vegetable kingdom. Vegetation in general, according to his opinion, went on by means of the pith. The seed itself was a small piece of pith, which separated from the whole, on purpose to go through the same revolutions as the old plant had done. But he proceeded still further, and ascribed to each part of a plant a certain peculiar power in forming one part of the flower. The calyx was formed by the bark, the corolla by the inner bark; the stamens were formed by the wood, and the pistils by the pith. He carried this hypothesis still further, by asserting, that in ligneous plants each branch required five years for the final evolution of the flower, and that each year something was added to the future flower. In the first year, for instance, the scales, (*squamae*), are formed, when the branch is shooting out from the bud; in the second year the calyx; the corolla in the third; in the fourth the stamens; and in the fifth the whole, for

the

the primary and successive formation of which, nature took all that time, is finished.

Linné may be right so far, that plants require a certain time to blossom; that in them previously a great quantity of sap, which has been carefully digested, to become fit for the formation of those important organs, on which all the propagation of the species depend, must be laid up; but that every year the rudiments of one part only, and of no other, are produced, is certainly not to be proved. As little can we suppose, that the pith alone is the only formative part in plants. We have seen already its use and its offices, (§ 268), and we know that it may be wanted, which is contrary to the old opinion. But that this pith, the bark, the wood, &c. should each form a peculiar part of the plant, is so much against common experience, that it is hardly necessary to refute it. We find in the springing flower, elongations of air vessels, but we never see elongations from each particular part, one forming the future calyx, another the corolla, and so forth. For instance, in the common sun flower, (Helianthus *annuus*), where in an immense large receptacle, numerous small flowers are placed, how should those elongations be able to unfold themselves into florets from the bark, inner bark, &c. through such a receptacle? There would arise a confusion amongst those small parts which is never met with. How should, besides, the stamina be formed in herbs, which are not ligneous, or the pistil, in plants which have no pith? Every one may thus easily conceive, that all those opinions are mere hypotheses, which may be refuted, even without the aid of anatomical dissection.

The flower does not always appear in the angles of the leaves or at the extremities of the stems, but in some plants it pushes forth in very uncommon places.

Rohria *petioliflora* has its flowers fixed to the petiole. The same we see in Salsola *altissima*, and some other plants. In most species of the genus Ruscus, the flower is attached to the middle of the leaves. It is seen on the margins of the leaves, in most species of Phyllanthus, Xylophylla, Polycardia, and one species of Ruscus, R. *androgynus*. On branches which are leafless appear the flowers of Cynometra *ramiflora;* Ceratonia *Siliqua;* Averrhoa *Bilimbi*, and *Carambola ;* Boehmeria *ramiflora*, and other plants. Most remarkable is the manner in which the flower is placed in a tree of the East Indies, called Cynometra *cauliflora*. This very leafy tree has no flowers, but at the foot of its stem ; its leafy top never produces any.

§ 286.

The flower, we know, (§ 66), consists of calyx, corolla, nectaria, stamens, and pistil.

The calyx and corolla are, with regard to the structure and distribution of their vessels, entirely like the leaves. The calyx, when green, as well as the leaves, transpires oxygen gas in sunshine ; but no transpiration takes place when it has any other colour. Both calyx and corolla imbibe the necessary food from the atmosphere, and convey it to the receptacle to which the flower is attached.

The nectaries, (§ 81), if not composed only of glands, agree in their structure with the corolla.

§ 287.

The stamens, (§ 86—88), consist of the filament and anther. They are likewise called the male organs of fructification. The filament, in the distribution of of its vessels, resembles either the herbaceous stem, or the leaves, according to the variety of its shape, which differs very much, but in each plant commonly bears a peculiar but constant character. The anthers are formed of a thin but vascular membrane, filled with pollen.

The pollen itself occurs under a variety of forms, which can only be seen with a microscope. Messrs. Jussieu, Du Hamel, Needham, Gleichen, and others, found, when viewing the pollen with a high magnifying microscope, that its globules, when brought in contact with water, burst with a degree of violence and emitted a gelatinous mass. Koelreuter, on the contrary, assures us, that ripe pollen does not burst so suddenly when wetted, but slowly emits through its pores, or if provided with small prickles, through those, an oily fluid, which on the surface of water forms a distinct shining pellicle. He says further, that each single globule of the pollen consists of two membranes; an external one, which is thick, elastic, cartilaginous, and full of very delicate vessels, which last are said to contain the pores which emit the oily liquid, and secondly an internal very fine membrane The internal surface is lined with very tender, elastic, cellular texture, which contains the oily fluid itself. Hedwig, however, after his latest researches, does not agree with Koelreuter. This great philosopher tells us, that each globule of the pollen consists of one vascular membrane only, filled in its interior with a gelatinous fluid, but has no cellular texture whatever. And, according to him, the pollen emits this fluid at once; it does not, as Koelreuter believed, ooze out through pores. Hedwig examined that portion of pollen, which had at the female stigma performed its functions, and he found his prior observation confirmed. Even the stamens of the mosses are, according to him, only globules of pollen acting as the others. Hedwig finds a great similarity between the pollen and the semen of animals, only, that as well as in the animal kingdom, it differs in consistence in different species. All observations indeed coincide in this, that the fluid which is contained in the pollen, is but a mere gelatinous fluid, which, however, cannot easily be mixed with water. This however is likewise proved by experience, that, though not an oil itself, it contains a considerable quantity of oil, for an oil may be obtained from it by pressure; it takes fire when thrown into a flame, and finally, bees prepare their wax from it. It does not however follow, that the whole is oily, for an almond cannot be called merely an oily substance because oil may be obtained from it, it contains this oil in a gelatinous mass.

A more important question, what constitutes the impregnating power of the pollen, or on what does it depend? remains still unanswered. Is it a subtile oily vapour, or a subtile volatile aura? or is it, according to others, electricity, or any other power? Still we are here in the dark*.

§ 288.

The female organs of fructification are the pistil, (§ 91—94), which consists of the germen, the style, and the stigma. The germen varies in its shape and structure in various plants. It is composed of all those vessels which we noticed in the rest of the plant, their direction and distribution only differing in each. The seeds, if the germen itself does not become a seed, lie in it, and are connected with it by the navel-string, (§ 114). In its interior it contains a clear fluid, in which nothing particular can be found. When the germen itself becomes the seed, the navel-string is very short. The internal structure of such a germen is the same, as that of the seed lying in it.

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* This leads me to mention a remarkable electrical phenomenon, in some deep red, or orange-yellow tinged flowers, which Linné's daughter first discovered. She repeatedly observed, in a dark evening, the atmosphere being calm and warm, a sparkling round the flowers of the Tropæolum *majus*. The same was afterwards observed by others in other plants. The Dictamnus *albus* affords another phenomenon. The very volatile fine oil, which in hot weather exudes from its flowers, can be kindled by a candle, and gives out a light blue flame.

The style, (§ 93), appears under a great variety of shapes. All the known vegetable vessels compose it, and it has hollow tubes, which at the top are by a tender cellular texture fixed to the germen and the navel-string.

Hedwig in his microscopical researches, found in the species of gourd, (*cucurbita*), and its kindred plants, near the stigma, hollow channels, in which he detected a firm, yellow, gelatinous body, which in the gourd was quadrangular, ran through the whole extent of the style, and ended in the navel-string of the seed. It appeared solid, and incapable of carrying any fluid. But as no doubt it has some office in the fecundation of the pollen, either as a conductor or as a conveying medium, he calls it *conductor fructificationis*. Its use, however, is not yet perfectly understood, and it is even not yet precisely ascertained, whether other plants have it, or if a different organization in other plants, answers the same purpose.

The stigma consists of hollow channels, the structure of which can be accurately viewed with the microscope only. Those channels or tubes constitute the stigma. What the Terminology calls stigma, (§ 94), is not always the real stigma, a very small part of it only deserves this name; at other times, on the contrary, the whole style is stigma.

The pappus, which is met with in compound flowers, (§ 72), and which exists completely formed in the ripe seeds, is certainly not to be considered, with Rafn, as a mere unorganic lifeless fibre. To me it appears to consist of large elongations of the exhalant vessels, which seem to contribute a great deal to the condensation and proper preparation of the sap. They indeed grow themselves at the very period, they perform these functions. When therefore the seed has attained its proper size, the vessels of the pappus become plugged up, and it remains dry upon the seed.

§ 289.

The stigma, now in its state of puberty, or when fit for impregnation, becomes covered with a fluid, which Koelreuter likewise considers as oily, but of the nature of which we know in fact very little. The period when the stigma is moist and the anthers burst, is the period of impregnation. This operation, however, is in plants performed in so very striking a manner, that we must be astonished, when we find how truly wonderfully nature has provided for all this. Most flowers are hermaphrodite, or such as have both male and female organs of generation, and one would from this circumstance be led to believe, that in such flowers impregnation would be immediately completed; but it happens otherwise.

Mr Sprengel has made numerous observations and experiments on this point, most of which are highly important. He discovered two principal ways in which seeds are impregnated, to wit, Dichogamy, (*Dichogamia*), and Homogamy, (*Homogamia*). He calls it Dichogamy, when in a hermaphrodite flower one organ of generation is first evolved, and after it has lost its fecundating power, another generative organ is formed. This is again of a twofold kind. Either the male parts are formed perfectly, before the female parts unfold themselves, which he calls Dichogamia *androgyna;* or it is the reverse, the female parts being first formed. This he styles Dichogamia *gynandra*. Homogamy is, when both parts of generation are formed in a hermaphrodite flower, exactly at the same period.

Now, in a hermaphrodite flower, when Dichogamy takes place, impregnation cannot naturally happen without intermediate means, by which both organs of generation may be brought near each other. Linné thought that the wind performed this, but there are few plants where wind could do it, as most flowers have such a shape as would rather impede the access of the wind than favour it. Koelreuter first pointed out that many insects serve this purpose, and Mr Sprengel had fortunately leisure and patience enough to look at, and to witness the manner, in which insects proceed in completing the impregnation of plants.

He found that various species of bees, and other flying insects, perform this important office; and he even observed, that some flowers had their peculiar insects, which alone visited it. His observations on this subject are indeed very numerous. Those insects, it is true, do not visit the flower on purpose to impregnate it, they only seek after the sweet juice which exudes from it. Their hairy body becomes covered with the pollen, and, whenever they visit another flower of the same species, the pollen is rubbed against the stigma, and impregnation is the consequence. And every insect that even does not visit one sort of flower alone, but many indiscriminately, will, during a whole day, remain with that species on which it first fixed in the morning, and not touch another, provided there be enough of the first species.

Those flowers alone which secrete a sweet juice, are visted by insects. Several of these flowers have one or more coloured spots, which Mr Sprengel calls *Maculae indicantes*, as they always indicate that a plant possesses honey, and, as he believes, make the insect more attentive. In hairy flowers the hair is always placed so as to prevent the rain from dropping in, and not to allow the insect to enter the flower at any place whatever, on purpose that it may be obliged to make its way across the stamens. The filiform and leaf-like appendages, which we enumerated amongst the parts of flowers, (§ 84), and which defend the honey, serve the same purpose. But it would be needless to give a more detailed account of the manner in which insects do this, as we can see it better with our own eyes, if the least acquainted with the structure of flowers. If we only look at the Iris *germanica*, at many flowers of the class Didynamia, at the Symphytum *officinale*, and many other plants, we will soon find ample satisfaction. One of the most singular ways of the fecundation of plants through insects, we have in the Aristolochia *Clematitis*. Fig. 271 represents this flower on a small scale; it has a linguiform corol, which at its inferior part is spherical, towards the top it becomes long and tubular, and its margins end in a flat and spear-pointed extremity. The pistil is placed in the round cavity of the corol, the germen of which is surrounded by six anthers, which are shorter than the germen itself. The germen has no style, but is provided with a hexagonal stigma, which is very shallow, and on its upper surface has imbibing pores. The anthers cannot empty the pollen upon the stigma, as the flower stands always straight upright during the period of flowering. The pollen therefore must necessarily fall to the bottom of the flower without being used, if no insects come near the flower. And indeed if it be tried, and all insects kept from the flower by a thin, but firmly closed piece of gauze, no seeds will be formed. It happens indeed not unfrequently, that as it is a particular insect which impregnates the flowers, when it is wanting or not able to find the flower, this last withers without having a single seed. This insect is the Tipula *pennicornis*. The round bottom of the flower is, in its interior, quite smooth, but the tubular extremity is lined with dense hair, every one of which is turned towards the interior, so as to form a kind of funnel, through which the insect may very easily enter; but can with great difficulty only return, and is obliged to remain in the cavity. Uneasy to be confined in so small a space, it creeps constantly to and fro, and so deposits the pollen on the stigma. After this is done, the flower sinks, the hair, which obstructed the passage, shrinks and adheres closely to the sides of the flower; by which means the insect gets free. Who but must admire the wise provision of nature in fecundating this seemingly trifling flower! Other instances of this kind could be mentioned. The dichogamic plants can be in no other way fecundated than by insects. Many flowers blossom in succession on one plant, and the restless insect, which flies from one flower to another, carries the pollen to them all. Epilobium *angustifolium* may serve as an instance of male Dichogamy, and Euphorbia *Cyparissias*, as an instance of female Dichogamy. Homogamic flowers, that is, such flowers as have their male and female organs of generation formed at the same time, are mostly impregnated by themselves. Several, however, are visited by insects, which complete what perhaps was not completed in the usual way, or what rain, wind, or unfavourable weather interrupted at the proper period.

In these flowers, the following arrangement is made: When the stamens are larger than the pistil, the flower stands either upright, and the stamens incline themselves over the pistil; or it lies horizontally, and the stamens curve themselves archways towards the style, so as to become of the same length with the pistil. Of the first kind the Parnassia *palustris* is an instance. In it the stamens, five in number, recline all over the pistil in the following order: First, one of the stamens places itself across the stigma, lets its pollen go, then rises up and resumes its former position. In the mean time the second is already following in the same manner, and as soon as the first rises from the stigma, the other covers it; the third succeeds like the two first, but as soon as it has risen, the two last come both at once. To the second kind belong the horse chesnut, (Aesculus *Hippocastanum*), and others.

But if in homogamic flowers the stamens are shorter than the pistil, the flower is pendulous, so that the pollen, when falling off, may be enabled to perform its functions. Rarely have such flowers an oblique or horizontal position, and in this case the style turns backwards, to reach the stamens. Some pendulous flowers, however, can only be fecundated by insects, as their stigma is so situated that the pollen does not directly fall upon it; but then these flowers have, as mentioned before, hair or other processes, which oblige the insects to enter them along the stigma; so that, when they return or visit the flower repeatedly, they must rub the pollen against the stigma.

Such plants, as on one stem have both female and male flowers, are mostly impregnated by insects alone. Only those impregnate themselves, which have no nectaries, or when the male flowers stand close to the female flowers, as in some species of gramina; Typha; Coix; Carex, and others. In that case such flowers have their female flowers situated lower than the male flowers, and their petals are very minutely or very deeply laciniated, so that the pollen when falling, can reach them. This is the case, for instance, with the different species of Pinus and similar trees. Here probably the wind too is of some service. It disperses the pollen in the air, so as often to involve the tree in a kind of cloud. The sulphur rain, as it has been called, which falls sometimes in spring, after thunder storms, is nothing else, but the pollen of the Pinus *sylvestris* carried about in the air by wind.

Such plants as have on one stem male flowers only, on another female flowers alone, are always provided with nectaries, and the male flowers are larger by far than the female, to allow more readily the insects to carry the pollen to their female neighbours.

The Valisneria *spiralis*, a water-plant of Italy, has the different sexes in different flowers; but here the male flower parts with the stem, and swims upon the water, that the aquatic animals may the sooner carry its pollen to the female plant. It is indeed a general rule, that all those aquatic plants which do not come under Linné's 24th class, can in no other way be impregnated but above the surface of the water.

Many foreign plants flower with us, having distinctly formed hermaphrodite flowers, but notwithstanding bear no seeds. The climate, however, is not always the cause of their barrenness, but the want of insects, which nature destined in their native countries to fecundate their seeds, and which we have not, along with the plants, received into our gardens. One experiment will confirm the truth of this observation: The Abroma *augusta* flowered for many years here, in Berlin, in a hot-house, where no insects had access, without ever bearing a single fruit. The gardener tried the experiment to put the pollen, by means of a hair-brush, upon the stigma of several flowers, and he got perfectly formed fruit, which again gave him new plants. In many other cases this has been done, which the limits of this work will not permit us to mention. Might it not be adviseable for gardeners, who wish to have cherry-trees or other fruit-trees bear very early in the season, when they often get little or no fruit at all, to place a bee-hive with bees in the hot-house, and at the same time, to take care to let these busy insects get at as many flowers as possible?

§ 290.

Nature seems to have given so very high a degree of irritability to some plants, merely to promote the *business* of generation. Berberis *vulgaris* has very irritable stamens, for if they are bent only a little, they instantly rebound back to the pistil. Dr Smith, however, found that a few parts in them only are possessed of this irritability. Cactus *tuna* has likewise a great deal of irritability in its stamens. If they are touched with a quill, they all incline over the pistil. As soon, therefore, as insects touch these irritable spots in those plants, the irritability exerts itself, and impregnation takes place. Many more plants have these kinds of stamens, for instance the whole family of Asclepias, &c.

The elasticity of some stamens certainly alone favours impregnation in some plants, for instance, in Lopezia; Urtica; Parietaria; Medicago; Kalmia; and others.

The style indeed of some flowers seems to possess much irritability, as it follows the stamens with its stigma.

The closing and opening of some flowers called their Vigiliae (§ 7), does not belong to this subject, though it may occasionally contribute something to the impregnation of flowers. It seems to depend on an increased contractility, or on an accumulation of the strong smelling transpirable matter. On the first it certainly depends in those flowers which, as it were, indicate rain, that is, shut themselves soon before rain falls. The fibre in the petals seems to act as a hygrometer, as in Calendula *pluvialis*, *hybrida;* Bellis *perennis*, and the like. Something similar happens in the Oenothera, though it remains open during rain. Perhaps some flowers, especially of the class Syngenesia, close in the evening for the very same reason. The Hesperis *tristis* and some others, which open in the evening, and diffuse their fragrant odours, unfold themselves at night time, by reason of the accumulated perspirable matter. But how shall we account for the Nymphaea *alba* opening in the forenoon, and closing again about four o'clock in the afternoon, and then remaining till the next morning immersed in water?

§ 291.

Koelreuter examined, in a very laborious manner, how many globules of pollen might be required to complete an impregnation. His chief discoveries on this point are as follow:

All the anthers of Hibiscus *syriacus* contained 4863 globules of pollen, 50 or 60 of which were necessary to complete impregnation. But whenever he took less than 50 globules, then not all the seeds ripened, but those, which were formed, were perfect. Ten globules were the least he could take in this flower, as less would not suffice for it. The Mirabilis *Jalappa* had 293 globules of pollen in one flower, Mirabilis *longiflora* 321. But in each of the two plants 2 or 3 globules were sufficient for impregnation. The seed did not appear more perfect, though many more globules were put upon the stigma.

To ascertain whether, in flowers with more than one style, each ought to become impregnated separately, Koelreuter in several of them cut all off but one, and the fecundation was as successful as ever. Even in flowers, in which the style was entirely separated, fecundation took place through one of them. These experiments shew, that the hollow tubes of one style communicate with all the rest, and that more styles and more pollen are formed, merely to ensure their final determination. From this circumstance philosophers have concluded, that the cellular texture of all germens fixed in the receptacle, must cohere amongst each other.

§ 292.

The great and wonderful process of generation has led various philosophers to form peculiar, and often very singular hypotheses of their own, which each has tried to establish by a number of arguments.

To give an accurate account of all of them, would be transgressing the bounds of our present researches; it will suffice to mention only the chief of them. Some of the oldest philosophers thought, that an accidental commixtion of solid and liquid parts was sufficient to form, according to circumstances, animals or plants. This was called *Generatio aequivoca*. Others imagined, that the small animals which were observed in the semen, (*animalcula spermatica*), go into the ovaries of the mother, and thus form the future being. Others again, believed that in the mother a rudiment of the future animal pre-existed, to which the semen of the male imparted life. This theory was called the pre-formation system, or the *Systema praeformationis*, *predelineationis*, or the theory of evolution. Those three appellations properly denoted three different ideas; but in reality they all concur in this one point, that all three suppose a pre-existence of the future being in the mother. Lastly, philosophers alleged, that the fecundating fluids both of female and male become mixed together, and thus give existence to the future animal. This theory was styled, *Epigenesis*.

The *generatio aequivoca*, was supposed in former times chiefly to take place in insects, worms and plants, but is now entirely abandoned by all rationalmen. Harvey's principle is now well known, *omne vivum ex ovo*, and we daily find this truth confirmed by new and bold observations, and the important conclusions of philosophers. I would indeed no longer rest with this old theory, did not some botanists explain the formation of Fungi, merely by the fermentation of putrifying vegetable matter. What led them to this, was their sudden rise, and the places which some of them always occupy. But there are likewise animals of the shortest duration, and others which are found on certain peculiar spots only, and no where else. To draw any conclusions from such circumstances is rather improper. And now, as the seeds and flowers of these plants have been discovered, this idea will be altogether abandoned. No organic body arises almost in any other way but from ova, (§ 296), and the *Generatio aequivoca* therefore is a mere nothing.

The theory of animalcula in the semen of animals being carried over to the ovarium of the mother, where the new animal is formed, has Leuwenhoeck for its author. Some therefore, in the vegetable kingdom, assumed pre-existing germs or corcles in the pollen, which in the mother's ovaries unfolded themselves into the future plant. A very zealous supporter of this opinion was Mr Gleichen. Some even went so far as to see, under the microscope, small asses in the semen of an ass, and small lime trees in the pollen of a lime. Strange things may be seen, if persons are disposed to see them. Koelreuter's observations, of which immediately, at once overthrow this doctrine.

The system of pre-formation, which in former times was much in vogue, is not, even by its most zealous admirers, much insisted on in the vegetable kingdom. Spallanzani, who in animals, by means of tedious experiments, attempted to prove the pre-existence of the animal, before the impregnation of the ovum in the ovaries, sincerely confesses, that there is no pre-existence of plants like that in animals.

The *Epigenesis*, or generation by a commixtion of the fluids given out both by male and female, is what most physiologists now assume as the only true theory of generation both in the animal and vegetable kingdoms. Koelreuter confirmed it by numerous experiments, of which we shall mention one only: He took of the genus Nicotiana, the Nicotiana *rustica* and *paniculata*. The first he deprived of all its stamens, and fecundated its pistil with pollen of the last species. Nicotiana *rustica* has egg-shaped leaves, and a short, greenish yellow corol. Nicotiana *paniculata*, a stem half as long again as the former, and roundish, cordate leaves, and much longer, yellowish green corols. The bastard offspring of both, kept in all its parts the middle betwixt the two species. He tried the same with more plants, and the result accorded perfectly with the first.

Were we therefore to admit the *animalcula seminalia*, the hybrids could necessarily not have differed in their form from the male plant; and, on the other hand, were the evolution system founded in nature, they would have the same form as the female plant. The hybrid, however, was a medium between both, it therefore certainly adopted some parts both from father and mother, and was formed by Epigenesis.

§ 293.

Koelreuter, however, could only obtain hybrids by intermixing similar plants. Dissimilar plants never produced them, even though, according to our systems, they belonged to one genus. It appears that nature thus avoids unnatural mixtures.

The instance of mules not generating, as it was once believed at least, induced many philosophers to make it an axiom, that hybrids are barren. But we now know a good many instances in Zoology of hybrids being very productive, and even the instance of mules does not prove any thing, as in warm climates they are sometimes prolific.

Koelreuter likewise found hybrids of various species of tobacco and some more plants to be sterile, the pistil in them being very perfect, but the stamens not completely formed. But there are now several instances of hybrid plants which retain their original form, and propagate themselves. I shall only mention a few with their parents:

Sorbus *hybrida*. The mother was Sorbus *aucuparia*; the father, Crataegus *Aria*.

Pyrus *hybrida*. The mother was Pyrus *arbutifolia*; the father, Sorbus *aucuparia*.

Rhamnus *hybridus*. The mother was Rhamnus *alpinus*; the father, Rhamnus *Alaternus*.

What mixtures do not the species of Pelargonium produce in our gardens? All plants of the 21st, 22d, and 23d classes of Linné mostly generate prolific hybrids. Linné wrote a particular treatise on hybrids, in which he attempted to explain the origin of some particular plants; but unfortunately he has given nothing but hypotheses, his observations not according with experience.

Should it not, from the observations made with regard to the hybrids of the animal and vegetable world, be laid down as a rule, admitting some exceptions, that all hybrids are productive, but that some only want a warm climate, to unfold the male semen? I do not attempt to establish this rule as quite certain; I should be happy, on the contrary, would philosophers consider this subject more accurately, and attend more to the hybrids of different climates, on purpose to settle the point.

But Koelreuter made some experiments, which put the doctrine of *Epigenesis* beyond all doubt. I shall only mention one of his observations as an instance. He obtained, as we have seen, a hybrid from Nicotiana *rustica* and *paniculata*. Nicotiana *rustica* was the female plant, *paniculata* the male. The hybrid, like all the others which he brought up, had imperfect stamens, and kept the middle between the two species. He afterwards impregnated this hybrid with Nicotiana *paniculata*, and got plants, which much more resembled the last. This he continued through several generations, till in this way, by due perseverance, he actually changed the Nicotiana *rustica* into the Nicotiana *paniculata*. By those and other experiments, often repeated, and made in various ways and upon other plants, it seems clearly established, that there is no pre-formation in plants.

According to the theory of Epigenesis then, the fluids of the male and female are mixed, and an offspring is obtained from these two, which in form and properties resembles both father and mother.

§ 294.

But there have been philosophers, as well in former as at the present times, who in plants have altogether denied the existence of sexes. Smellie seems to favour this opinion, because he repeated an experiment of Spallanzani's, with a female plant of hemp, which he kept remote from all male plants, and notwithstanding obtained, though in a small quantity, perfect seeds, and hence he deduces his arguments. But indeed such experiments are too difficult to be free from error, and who can assert, that he has not, even with the greatest attention, been deceived? Spallanzani placed his female plant in a room, to which no insects could get, and, for the greater security, likewise covered it. But could he, before the first flower appeared, distinctly enough distinguish the female plant of the hemp? And could not a very small, minute insect escape his eyes, and effect a fecundation? Besides, do we not find on female plants sometimes a few male flowers, which perhaps was here the case? The few seeds which he got, prove, that a few single parts were necessarily fecundated. But even supposing that in hemp the female plant produces ripe seeds without fecundation, can we draw any just conclusion from this single plant to any other vegetable? We have in the animal kingdom an instance in the Aphis, an insect which, without the aid of a male, propagates itself till autumn. But who would, from this isolated observation, founded as it is in truth, attempt to deny in all animals the existence of a difference of sex? Since Gleditsch first, in a botanic garden, impregnated the Chamaerops *humilis*, which is a female plant, with pollen of the male plant, which Koelreuter sent to him from Karlsruhe, and obtained ripe seeds and young plants, which before never had been possible, thousands of similar experiments have been made which put it beyond doubt, that two sexes exist in plants. Every person may indeed easily convince himself of the fact, by repeating such experiments on the species of melon and gourd, and everywhere in the vegetable kingdom, he will find two distinct sexes.

§ 295.

Each seed, as we know, (§ 288), already exists in the germen during the time of blooming, before fecundation takes place, and contains a very clear liquor, called by Malpighi the Chorion. With this, most likely, the fecundating particle of the male semen become mixed, and thus produce the embryo of the new plant. Koelreuter, on the contrary, thinks that the moisture of the stigma, which he, according to his favourite idea of an oily, impregnating fluid of vegetables, supposes likewise to be of the nature of oil, becomes mixed with the fluid of the male, and that these two combined, are conveyed into the seed. However, though this may be true, many other changes take place in the seed sooner or later after fecundation. For in the neighbourhood of the navel a small vesicle appears, filled with some liquid The first is called the *sacculus colliquamenti*, and the liquor in it, the *amnios* This vesicle grows larger, absorbs the chorion, which at last entirely disappears, and finally becomes the *membrana interna* of the seed, (§ 114). The *amnios* grows hard, and forms the cotyledons, (§ 114). As soon as the vesicle shews itself, the embryo of the future plant likewise appears gradually, which is, properly speaking, the corcle, (*l. c.*). It is formed gradually, and becomes visible in the sunflower, (Helianthus *annuus*), three days after impregnation; in the cucumber, (Cucumis *sativus*), a week after; and in Colchicum *autumnale*, some months after. It is soft in the beginning, but in time becomes, like the vesicle which contains it, of a better size and firmness. The vesicle does not in all seeds increase in the same form, in some it grows larger in its whole circumference, in others it grows longer towards one extremity, and the sides afterwards become extended.

§ 296.

Thus the seed comes to maturity, and when perfectly ripe, separates in different ways from its mother plant, and begins a new life itself, passing through all the scenes again, just now explained. This is the common way in which plants are propagated. But we have plants, which do it in another way besides evolving their seeds. At the stem, or near the angles of the leaves, nature or even accidents form sometimes knots, which become buds, and separating spontaneously from the plant itself, send out roots and leaves, and form an entirely new plant of the same species. Such plants are called, viviparous plants, (*vegetabilia vivipara*). Several species of garlic, (*allium*); the Lilium *bulbiferum;* Poa *bulbosa* and other plants, shew this phenomenon spontaneously. The garden tulip, (Tulipa *gesneriana*), exhibits this curious phenomenon by means of a simple manœuvre of art, if the flower is cut off, before impregnation has taken place, and the stem with the leaves be allowed to remain, provided it be in a shaded spot. Several succulent plants, for instance, Eucomis *punctata*, do it when treated in the above manner. Thus gardeners produce a greater number of young plants, by grafting and inoculating with cions, and by other similar processes. The bud of a tree or shrub, when grafted into another stock, will there be unfolded, and must indeed be regarded as a different plant altogether. It is not changed in its nature, but grows as if placed in the earth; the stem only serves to convey the imbibed sap to it, which it must digest itself.

Agricola and Barnes, it appears, were more successful in these operations, for they placed buds directly in earth, and produced perfect young plants.

§ 297.

The stem of ligneous plants, we were informed, (§ 260), annually adds a new ring of vessels. The first and oldest of these circles begin to become ligneous on their sides. The wood has in general, when young, a yellowish white colour, which, according to the species of the plants, assumes a darker hue every year. The quick circulation of the sap only takes place in the young vascular circles; in the older ones the sap is carried along much slower, and they have their irritability greatly diminished. Life in every shrub or tree is seated only in the youngest rings of these vessels, which we now know under the name of the inner bark, (§ 280), and the plant must die when this is wounded. Thus if a ligneous plant has performed its offices for a number of years, then the innermost ring begins to be plugged up, and to become more and more impervious. Whence its neighbours no longer obtain any moisture from it. They therefore begin to move their sap slower, and the youngest vascular circle becomes gradually thinner and thinner. At last the sap stops likewise in the following ligneous circles: the youngest vascular ring cannot form itself completely; few buds are now unfolded; the small number of leaves cannot prepare sufficient sap for the whole, and the common certain lot of organized bodies, death, stops the machine entirely.

§ 298.

In herbaceous plants all the vessels of the stem become dry and hard in one twelvemonth, and as therefore they can no longer convey the sap, the stem decays at the end of the year. Their root forms, as the stem of ligneous plants does, annually a new vascular circle, and it dies itself at last, when all those circles have become too ligneous. But such herbs, the roots of which are annually renewed, are of constant duration. The old root dies, its fibres being entirely ligneous, but a new one appears, and is in fact the young plant.

§ 299.

Herbs, however, whether they live one year only, as the annual plants, or two years, as all biennial plants, become so exhausted by the formation of the flower and fruit, that the irritability of their vessels becomes much impaired; they therefore become quite ligneous, and their root and stem must decay after its fruits are ripened. They may, however, be preserved for several years, if their flowers, when in the bud, be taken off. The same happens when their flowers are filled, in which case fecundation does not take place and no fruit is formed. These vessels, therefore, retain that irritability which is necessary for their duration, and which would have been lost by the wasting of their strength, and their fibres become only slowly ligneous.

§ 300.

This natural death, however, does not come upon all plants in the same manner. It is indeed of a double kind. In most plants death ensues as in large animals, by induration of the vegetable fibre. But in soft Fungi and the species of Boletus it happens quite the contrary way. These plants imbibe much moisture, which increases when they become older. In them no part becomes ligneous, but they die in a soft state, from superabundance of moisture, and are almost dissolved in it.

§ 301.

The duration of life differs greatly in different plants. Some species of boletus only require a few hours to unfold themselves, and as soon again decay. Several fungi live only a few days, others weeks and months. Annual plants live three, four, or at the utmost eight months. Biennial plants continue sixteen, eighteen, and even four and twenty months alive. Many herbaceous plants grow a few years only, but more a long series of years. We have some shrubs and trees which can live eight, ten, a hundred, even a thousand years. With us the oak and lime-tree come to the greatest age. But the trees which in our globe in general grow oldest, are no doubt the Adansonia *digitata*, (§ 263); the Pinus *cedrus*, and the different species of palm. The Adansonia probably lives longest of all, as its age is computed to be one, if not many, thousand years.

VI. DISEASES OF PLANTS.

§ 302.

PLANTS are, like all other organized bodies, subject to a great many accidents and diseases. The most common causes are, improper soils, preternatural habitations, late frosts at night time, long continued rain, great drought, violent storms, parasitic plants, insects and wounds of various kinds.

Disease we call in plants that preternatural state by which their functions, or at least some of them, are disturbed, and the purposes for which they are destined annihilated.

§ 303.

The diseases of plants are of different kinds; they attack either the whole plant, and are then called general diseases; or they only affect single parts, when they get the name of local diseases. Sporadic we style those diseases, which of a great number of the same species of plants, only attack one or the other. Epidemic, on the contrary, when they invade a great number of plants, such as gangrene, necrosis, rubigo, and others.

§ 304.

These diseases of plants are either such as are brought on externally only, by accidents and the like; or such as originate from a corruption of the sap and other internal affections destroying organization itself. To the first kind belong wounds, fractures, fissures, preternatural defoliations, haemorrhagy, mildew, honey-dew, rubigo, lepra, galls; the folliculus carnosus, contorsions, warts, moles, squamations, the bedeguar. To the second class of diseases belong chlorosis, icterus, anasarca, phthiriasis, verminatio, tabes, deliquium, suffocatio incrementi, exulceratio, carcinoma, necrosis, gangraena, ustilago, mutilatio, monstrositas, sterilitas, and abortus.

§ 305.

Vulnus, or a wound, is a separation of the solid parts by external violence. It is given either purposely by cutting off branches and the like, or happens accidentally, by cattle, for instance, rubbing against a plant; or from friction of two plants, or by the wind agitating the stem; by the bite of animals, by a separation of the parasitic plants, or even by large hailstones. In all those and similar cases, it is necessary to prevent the access of air to it, by some good firm cement, or grafting wax. But if the wound has remained long uncovered and exposed both to wind and rain, and is of a great size, then the affected part must be taken off as far down as the sound wood, to prevent greater mischief, and the whole afterwards be covered with wax.

The means to prevent wounds are obvious.—branches must be taken off with care; cattle excluded from the neighbourhood of plantations; trees brought up so, as not to require to be fastened to stakes; or, if necessary, to place three or four posts or stakes round each, and tie them up very gently. In violent storms it is indeed better to let them loose and leave them to themselves. Parasitic plants must be eradicated. But hurts by the bite, especially of smaller animals, and by hail, cannot always be prevented.

§ 306.

Fractura. Fractures are, when a stem or branches break, or are violently divided into many pieces. This arises from the violence of the wind; from a great abundance of fruit; heavy weights of incumbent snow, and from lightening. It may be mentioned as singular, that lightening runs along different sorts of trees, almost always in a different manner. The birch, (Betula *alba*), is in this respect different from all other trees, for in it the lightening never runs along the stem, but strikes only at the top, where it beats off the boughs almost in a circular direction.

A fracture, if not complicated, and on branches or young stems only, may be healed without difficulty. But if accompanied by contusion, or happening in trunks of old gummy trees, recovery is impossible.

In young trees and branches, even sometimes in old ones, when instantly discovered, fractures heal easily, especially in spring till the end of June, provided every part be brought into its natural position, firmly tied up, and properly supported. But if there is contusion, or if a thick stem or bough is fractured, then the whole must be taken off, or the stem cut down, to get new shoots, from the stock or the root.

To prevent such an accident, trees with very tender boughs, must be as much as possible sheltered from the wind; fruit-trees ought, when pruned, to have some of those buds, from which a fruit may be expected, cut off, and after a great fall of snow in gardens, this load should be taken off from the branches. Against the irresistible power of lightening, no means are of any service, except conductors, which however, would be too expensive, and even prove impracticable.

§ 307.

Fissura. Fissures or clefts are, when a solid part splits spontaneously in its length so as to leave a cleft. It has two causes, superabundance of juice or sap, *(polysarca)*, and frost.

To heal a cleft of that kind, nothing else is required than to put good grafting wax on the wound, that no rain or other contents of the atmosphere may destroy the stem.

To prevent clefts, the bleeding or scarifying, as it is called, of such trees, the bark of which is very hard, may be of service. A moderate incision is made through the bark longitudinally; and a plant which stands in too rich a soil, which of course will produce an increase of the sap, should be transplanted into a poorer soil. To defend them against frost, plants should be covered with straw.

A cleft occasioned by the last often degenerates into a chilblain, *(pernio)*, from which afterwards, especially in oaks, a blackish sharp liquor exudes, which at last produces exulceration, (§ 327).

§ 308.

Defoliatio notha, when the leaves fall not at the proper period, but much earlier. The injuries of man, insects, acrid pungent fumes, dust, and constant dry weather, have this effect.

In whatever way it may happen, all depends on the nature of the plant affected with it, and on the season of the year in which it happens. If it be a fast growing tree, and the injury happens before August, the tree may, if taken good care of, easily get leaves again, only it will have but a few and small leaves for the present season. But if the leaves fall, after that period, and cool weather comes on earlier than usual, or if it happens at a much later season, the plant may be unwell for several years, before a complete recovery takes place. If, on the contrary, it happens late in autumn, just before the natural fall of the leaves, then it has no bad consequences, except the plants be natives of a warmer climate, and the branches, which have appeared already, be not yet hard enough, in which case they will lose those branches, and perhaps some of the older ones, by the invasion of cold. To deprive trees of their leaves purposely, which is done sometimes in spring, particularly with the mulberry-tree for the silkworm, should be avoided, or at least be done with moderation and caution.

Insects which are noxious to plants, should be accurately known, and their way of propagation understood, to obviate all the bad effects they produce, and to stop their great increase.

Change of place is the only means to prevent the noxious influence of acrid fumes, of great manufactures and iron-works and the like, as well as of dust.

In very long continued dry weather, careful watering is highly requisite.

The falling off of the leaves in autumn is quite consistent with nature, and of no bad consequence whatever, except perhaps when the leaves are dropping off too soon, on account of early frosts, which however will only affect very tender and foreign plants, of which care should be taken.

§ 309.

Haemorrhagia, or the great loss of sap, is of a twofold kind, either caused by wounds, or spontaneously. The species of birch and oak are very apt to lose a great deal of sap when wounded, which, when not stopped, may kill the tree.

Spontaneous haemorrhagy arises either from acrimony of the chyle, or from too great an increase of the sap. When the first is the cause of it, no remedies are of any avail, as the plant soon dies, and its vessels become corroded. Spontaneous haemorrhagy, from superabundance of sap, is either gummous,

mous, as in fruit-trees, or watery and limpid, as in the vine. This last species has been styled *lacrymatio.* The gummous haemorrhagy proves rarely fatal, but should not be allowed to make too much progress, and the wound should be healed up by wax. That which happens especially in the vine, has no bad consequences whatever. For this plant performs the same functions in winter as all ligneous plants, (§ 277). The radicles of it, which have been formed during the cold season, imbibe a great deal of moisture from the ground, which they convey to the stem. But as the weather is not soon enough favourable for the shooting of it, and as the radicles take up more sap than the tender stalks can keep in, the superfluous sap exudes from the gems or buds. In warm climates the vine does not lacrymate; for there the leaves can unfold themselves instantly, and the sap of course is properly digested. This watery discharge of the vine is not therefore to be considered as a natural secretion peculiar to the plant, but as the effect of cold climates. It however does not hurt the vine.

§ 310.

Albigo or mildew, is a whitish, thinnish coating of the leaves of plants, which often causes their decay. It is produced by small plants, or by insects. The first kind appears on the leaves of Tussilago *Farfara;* Humulus *Lupulus;* Corylus *Avellana;* Lamium *album; purpureum*, and others. It is a species of fungus of great minuteness, which covers the leaves: Linné calls it Mucor *Erysiphe.*

The second kind is a whitish slime, which some species of aphis leave upon the leaves.

As soon as there is the least appearance of mildew, all the leaves stained with it should be plucked off and burned. In scarce and delicate plants, the leaves ought to be washed. But where it is produced by aphides a weak decoction of the dry leaves of tobacco will be found most serviceable.

Jf, on the contrary, all parts of a plant are full of it, and the plant is hard and of long duration, then the parts must, according to what plant it is, be taken off. If it is an annual, and of great delicacy, it will be best to wash it, with a brush dipped in the decoction of tobacco, and afterwards to expose it to the open air.

§ 311.

Melligo, or honey-dew, is a sweet and clear juice, which during hot weather is frequently found upon the leaves, rendering them sticky, and, especially when it does not rain, causing them to fall off. This sweet matter is likewise secreted by aphides, from peculiar glands at the anus.

In tender plants washing with water, or with the above decoction is of great benefit; the fumes of tobacco likewise kill the insects.

§ 312.

Rubigo, or a red matter of the appearance of rust, is seen frequently on the leaves and stems of many plants. It consists of yellow or brown stains, which when touched, give out a powder of the same colour, which soils. Microscopical examination has shewn, that this rust-like matter consists of small fungi, which are called Aecidium, and the seeds of which form this brownish powder. We find them frequently in the leaves and stems of Euphorbia *Cyparissias*; Berberis *vulgaris*; Rhamnus *catharticus*; and some gramina; of wheat, oats, &c. If they are very numerous, especially in the different species of gramina and corn, consumption is the consequence.

Little is to be done against this affection. In the species of wheat, oat, and the like, some have recommended to moisten the grain, before sown, in salt, or lime water, or to sow grain from countries where this disease does not prevail. Palliatives, or preservative means, are of no use.

§ 313.

Lepra is frequently met with on the trunks, especially of young trees. If trunks are so entirely covered with algae, that the pores of the cutis become shut up, we call the distemper *lepra*. Old trees have their trunks full of algae, without suffering in the least, provided the smaller branches be free of them. But if young trees or shrubs grow in too sterile a soil, or in too thin a stratum of fertile soil, or in gravelly soil; in improper situations, the ground being either too moist or too dry, and the plants, against their nature, too much exposed to wind; then they sicken, their bark cannot perform with proper vigour the functions peculiar to it as the skin of the tree, and they grow at last, even at their young boughs, all over with fungi of all kinds. Vigorous plants, therefore, though their close neighbours, will have few or no fungi on their stems.

The lepra increases sickness in plants, and they die at last of a decay, if not cleared of the fungi all over their cutis, and transplanted in better situations and more proper soils.

§ 314.

Gallae, or galls, are produced by a small flying insect; the Cynips of Linné. Galls are round, fleshy, variously shaped bodies, which are attached to the stem, petioles, peduncles, and the leaves. They are formed in the following manner: The little insect pierces with its sting the substance of the plant, and deposits its eggs in the small opening left. The few air vessels thus injured get a different direction, and twist round the egg. The irritation which the sting produces, occasions, as always in organized bodies, a greater flow of the sap, (§ 280), towards the wounded place, which is deposited in greater quantity than it ought to be, and a fleshy excrescence is the product. The little larva which leaves the egg, is nourished by the sap, grows up, changes into a pupa, and escapes at last as a perfect insect, which propagates itself again in the same way.

It is singular, that each particular fly produces a gall of a peculiar form. This perhaps may depend on the peculiar structure of the eggs of each species; for we find that the eggs of different insects, when viewed with the microscope, assume peculiar shapes. On the oak-tree we find a variety of galls, likewise on the Salix, Cistus, Glechoma, Veronica, Hieracium, Salvia and other plants.

The galls of Salvia *pomifera*, which got its name from that circumstance, are said to be of a pleasant taste, and considered as an excellent dish in the oriental countries.

To remedy this affection, we can do nothing, but cut off the galls as soon as they appear. This however cannot be done in very delicate plants, if we wish to preserve them. The disease in fact rarely proceeds such a length, as to hurt the plant materially.

§ 315.

The *Folliculus carnosus foliorum*, is a gall of a particular kind, which is subulate and acute. It is found in Populus *nigra* and Tilia *europaea*, and covers the whole surface of the leaf. It arises in the same way as the former, but being more frequent oftener produces disease.

Contorsions, (*contorsiones*), owe their origin likewise to insects, which produce a swelling of the leaves; hence they become contorted, which is the characteristic feature of the disease. It occurs in Cerastium, Veronica, Lotus, Vaccinium.

§ 816.

Verrucae, or warts, are small tumours, which occur chiefly in fruits, for instance, in apples. Here insects are not the cause, but accidental occurrences. Of the same kind are the (*naevi* s. *maculae*), moles. They arise from wounds of the cutis. Both diseases are harmless, and, as yet, we know no means to prevent them.

Tuber lignosum is met with on trunks of trees. It seems to be produced partly by insects, partly by changes of weather. It arises from a disturbance in the active vessels of the inner bark, which by the application of stimuli, become several times convoluted without forming buds or boughs. They form instead of this, great knobs, which often, in a bad situation, especially through moisture, exulcerate. They not unfrequently grow very large, without the least injury to the tree.

§ 317.

Squamationes, or spongy swellings, are produced like galls. A small insect lays its eggs in the apex of a bud. Thus injured, the branch, which was to evolve itself from the bud, cannot be properly unfolded, it remains quite short; all its leaves, therefore, expand themselves from one point, but they are of small size. The whole has somewhat the appearance of a rose. This may be often seen, particularly in willows.

Such spongy swellings are of bad consequence when in great numbers. The only way to extirpate them, is, to cut them off, before they are properly formed.

§ 318.

The *Bedeguar* occurs in roses only, and has the same origin as the former, with this difference, that the insect which gives rise to the Bedeguar, deposits a number of eggs in one heap in the middle of the bud. From this a fleshy mass of the size of a fist arises, covered all over with hair-like coloured processes.

§ 319.

Chlorosis is that affection of plants, when their green colour entirely disappears, and all their parts grow whitish. It arises from this circumstance, that these plants cannot excrete their oxygen, which therefore becomes accumulated. There are three causes of the disease, want of light; insects; and bad soil. We saw before, (§ 278), that a healthy plant emits oxygen gas in sun light, and that the accumulation of this gas, when not emitted, makes the green colour disappear, (§ 281).

As soon as a plant is deprived of light, it cannot disengage the oxygen, hence it assumes a white colour, which however instantly goes off, when the rays of the sun are again admitted. This is the reason why plants, in dark rooms, between great masses of stone, in deep clefts of rocks, beneath the dark shade of shrubs and trees, &c. grow pale, and of a whitish colour.

Insects which bite off the radicles of plants, or even nestle in them, and consume their food, debilitate their vessels, render them insensible of the stimulus of light, and at last chlorotic. It occurs very frequently in Secale *cereale*. No remedies are of any use.

Improper soil, from which plants do not get food enough, not unfrequently brings on this affection.

In such case plants may sometimes recover by change of soil.

§ 320.

Icterus differs from chlorosis, only in its colour and by its cause, which is cold coming on early in autumn. It is indeed the natural death of the leaves, and may only hurt the plant itself, when the cold begins in autumn before due time.

§ 321.

Anasarca, or dropsy, arises in plants from long continued rain, or too profuse watering. Single parts in this case become preternaturally swelled, and commonly putrify. Some of the bulbous and tuberous roots, for instance, are often greatly swelled after rain. Fruits lose their taste, and become watery. Seeds do not get ripe or the plant pushes out young shoots unseasonably from the stem. Most of the succulent plants suffer from too copious a supply of water.

Anasarca in plants is generally incurable.

§ 322.

Phthiriasis is that disease of plants, where the whole of it is covered with small insects, which feed on its sap, disturb the important operation of transpiration, and of course hinder the future evolution of its parts. This disease is produced by three different species of insects. In the first place, by the aphis, of which each plant has almost a peculiar species. Secondly, by the Coccus, of which there are various species. That which in our hot-houses is mostly met with, the Coccus *Hesperidum*, is the most dangerous; those which are commonly found on the roots of Scleranthus, Polygonum and others, are less noxious. The disease is lastly produced by the Acarus *tellarius*, a small mite, which in hot-houses likewise spins a very delicate web over the leaves of the plants, and thus destroys them. Against the first species, careful cleaning or even brushing with suds, or a decoction of tobacco; or fumes of tobacco in close rooms, may be of service. The same means may be tried with advantage against the second species, where it may be likewise very beneficial to place the plant as soon as the temperature is mild in the open air, in a shady, but airy place. This last we use likewise to get rid of the Acarus, which in hot-houses chiefly attacks the genera Sida, Hibiscus, Dolichos and Phaseolus.

§ 323.

Verminatio, or worms, is not the same affection as in animals, for it is not worms which produce it, but the larva of insects. Stem, leaves and fruits suffer more particularly from it. The stem of some trees is very often eaten through, and often dies on this account. The willow, (Salix *alba*); horse-chesnut, (Aesculus *hippocastanum*); the Typha *latifolia*, may serve as instances.

The leaves are often inhabited by the mining-worm, as it is called, especially the leaves of cherry-trees.

Fruits, as plumbs, apples, pears, hazel-nuts, and the grain of corn and the like, often contain the larvæ of insects, which destroy them.

Except the destruction of the larva no remedies will resist these ravaging enemies.

§ 324.

Tabes, or the wasting of a plant, is frequently a consequence of the already mentioned diseases, or those which we have still to explain. Its causes, however, are likewise, sterile or improper soil, unfavourable climate, clumsy planting, exhaustion of strength from too frequent flowering, insects, ulceration, and the like. The whole plant gradually begins to decline, and dries up. As soon as this disease really appears, help is rarely possible.

There is a kind of tabes in pine trees, which has been called Teredo *pinorum*. It attacks principally their alburnum and inner bark. The causes of this disease are, long continuing dry weather, or violent frost of long duration, especially after preceding mild or warm weather, and violent gales of wind. Its signs are, an unusual colour of the acerous leaves, as they are more of a reddish yellow hue. A great number of small drops of resin in the middle of the boughs, and a putrid, turpentine-like odour spreading in their neghbourhood; lastly, the bark scaling off, and the alburnum presenting a blackish blue appearance. At the same time the tree is full of insects. This is an incurable disease, and in large forests nothing more can be done than strictly to prohibit, that the leaves or the moss round the roots of the pine trees, be not cleared away, as this weakens the trees, and pre-disposes them to the disease.

§ 325.

Debilitas, s. *deliquium*. Plants which suffer from debility have all their parts, stem, leaves, flowers, &c. hanging down quite flaggy and loose. Debility owes its origin to foul air, want of light, of leaves, or of moisture. Even to great intensity of light and other causes, which must be removed as soon as possible.

§ 326.

Suffocatio incrementi, or ill growth, is when plants grow little, and remain weak and feeble; their leaves in that case become pale, they shrink together, and at last the whole decays. This is different from the last disease. The causes of this are only accidental and may be removed, so that plants may still recover. These causes are, parasitic plants and others, which twist round and attach themselves to their neighbours, and too glutinous soil. When those impediments to growth are taken off, the plants will soon be as well as ever.

327.

Exulceratio. Ulcers are formed when a part of a plant becomes corroded, and discharges an ichorous liquor. Wounds degenerate into ulcers if not properly covered, or if placed in such an unfavourable place, that rain or snow remain in it and become fusty. Insects sometimes bring on an exulceration, and other unknown causes likewise produce it spontaneously. No ulcer heals up by itself in plants, and it will do more or less harm, and even prove fatal, the slower we are in giving proper assistance. All ulcerated parts ought to be taken off, and the sound parts covered with a coating of grafting wax, or of Forsyth's cement. An ulcer often corrodes wood, pith, or other parts of trees, from a neglect of the gardener; in this case all that is affected, must immediately be cut away, and as just now mentioned, the access of air must be prevented by the application of some grafting wax or cement.

From unknown causes the bulbs of hyacinths and other fleshy roots exulcerate. Those too must be healed by putting them in a dry place, taking off the diseased part, and covering it with cement. However, we rarely succeed, as the bulbs are mostly corroded to the very centre*.

§ 328.

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* The best external remedy for plants is the grafting wax, if carefully prepared. In many cases, however, especially for large wounds, Forsyth's cement, for the receipt of which the king of England payed 3000l. is by far preferable to the former. This last consists of 16 parts of cow dung, 8 parts of dry lime taken from an old building, as much charcoal, and one part of sand out of a river, which are to be mixed together into a thick mass. In place of the cow-dung, ox's blood, and instead of the lime, dry carbonat of lime may be employed. This cement is to be spread thinly on the affected part, and to be rubbed with a powder, consisting of 6 parts of charcoal, and one part of the ashes of burnt bones or car-

§ 328.

Carcinoma arborum, or a cancerous affection, occurs principally in fruit-trees, when they lose too much gum, and this undergoes an acetous fermentation. A great spongy excrescence rises, which even in the driest weather discharges an acrid ichor, which corrodes every thing. We have two distinct species, the open and the latent cancer. The first species is easily seen, and cured by simply extirpating the affected part. But the second species may have spread far in length and breadth, before it can be discovered. Then we must hasten to save the tree, the cancerous parts must be taken off, and Forsyth's cement afterwards applied to it.

To prevent the disease, change of place and good care, to obviate too much formation of gum in fruit-trees, will prove beneficial.

§ 329.

Necrosis, or dry gangrene, is that disease which makes the leaves or other parts to grow black and

bonate of lime, till the surface of the cement is as smooth as if polished. Forsyth did wonders with this preparation, and cured with it almost all external affections of plants without any further trouble. It does not keep well, and therefore only as much of it must be prepared, as is wanted for the time, or, if it is to be kept for some time, it ought to be moistened with urine. It should further only be applied during dry weather, on purpose to cover the wound with new bark. Rafn asserts, he had experienced the same good effects from a mixture of pounded coal and potatoes, or some other soft subtance, and even prefers this to Forsyth's mixture.

dry. Late night frosts, severe cold in winter, burning heat, corruption of the sap in single branches, and smaller plants, are its causes.

Frost coming on at a late period in spring, very frequently kills young shoots of plants, which therefore grow black, and shrink up. To obviate this accident, young plants should be covered as soon as cold nights may be dreaded. Others derive great advantage from conductors of frost, as they style them, that is, from a compactly twisted cord of straw, directed into a vessel with water. From severe winter cold, foreign trees suffer chiefly, and such of our native plants as are very delicate. Their inner bark becomes frost-bitten, turns black, and it is impossible to save them. The whole must be clipped, and the main trunk with the roots only be allowed to remain, to produce new shoots. Intense heat will produce the same bad effects in gardens, or even in forests, where forresters are permitted to clear away the mosses and dry leaves from the roots. Single branches sometimes, by the too rapid growth of others, are deprived of their necessary food, they become dry and fall off. This may happen without any injury to the whole. Smaller plants sometimes induce this disease, most frequently in the bulbs of the saffron, where a species of Lycoperdon occasions it. One part of the coast of Africa, the gold coast, is infested by a wind called Harmattan, which kills the plants, making their leaves dry and black.

§ 330.

Gangraena. Plants affected with gangrene become soft and moist in some single parts, which at last dissolve in a foul ichor. It chiefly attacks fruits, flowers, leaves and roots, rarely the stem. Gangrene arises either from too wet or too fat and luxurious ground, from infection and contusion. It scarcely admits of a cure, especially as it only infests single parts, but may be prevented by a removal of its causes.

§ 331.

Ustilago. This singular variety of gangrene occurs most frequently in the species of gramina, rarely in other plants; sometimes in Scorzonera, Tragopogon, &c. It arises from a small fungus, which occupies the whole ear, (*arista*), which therefore cannot form itself properly. Every part of it, on the contrary, becomes a black, soiling mass. Moist seasons are most favourable for it, and its progress is under such circumstances very rapid.

That corn may not be affected with it, such grain only should be sown, which has not been kept in damp places, nor has been got from where the disease prevailed. Neither should the grain be placed too deep in the ground, especially where the soil is fat, and the ground moist. When, however, it has once begun, the plants diseased cannot be cured. In tender and scarce garden plants, something may be done by amputating the diseased part just forming.

But this would be as an operation too troublesome and precarious.

§ 332.

Mutilation happens especially in flowers, and the name *flos mutilatus* is used, when single parts of a flower, particularly the corol, are not quite perfectly formed. The causes of this mutilation are, unfavourable climate, and improper soil. Flowers, notwithstanding this mutilation, often bear perfect seeds.

The species of violet, Viola *odorata* and *canina*, produce not unfrequently in our climate, if the weather is not warm enough, flowers wanting the corols. Campanula *hybrida* has in one part of Germany no corols, but is said to have them in France and Italy. In several of the companulate flowers we see sometimes the corol wanting, for instance, in Campanula *pentagona*, *perfoliata*, *media*. Some other plants, as Ipomoea, Tussilago, Lychnis, are liable to the same accident. Ruellia *clandestina* is thus called, because it has sometimes flowers wanting the corols. The same is said to be the case in its native country, Barbadoes.

Hesperis matronalis, during long continued moist weather, from superabundance of food, frequently bears flowers, where the corol has begun to form a second calyx.

The common clove pink, (Dianthus *caryophyllus*), augments the scales, (*squamae*), of its calyx so much that the flower becomes somewhat like the ear of wheat, and the corol never appears. Less conspicuous is the deformity, when a few stamens only are not so properly formed as they ought to be.

§ 333.

Monstrositas. When single parts or whole plants have a preternatural form. In flowers or fruits the monstrosity is often such, as to annul their use entirely.

The stem is sometimes writhed, bent, knotty, too much depressed, and in a lying posture. Cold climates in general make plants rough, small, and crippled. On high mountains the tallest trees are at the summit reduced to a small size.

Leaves not unfrequently become deformed, either larger or more numerous, thicker, or frizzled. Every person has seen trefoil with four leaves, or the preternaturally red coloured leaves of the beech tree, and others like it.

Fruits likewise are variously deformed, they are either very large or very small, grown together, crooked, and the like. These may, however, produce good seeds. But fruits which are doubled, where, when one is cut, a second one appears in its interior, as sometimes happens in lemons, and fruits which have no seeds, as for instance, the Bromelia *Ananas ;* Musa *paradisiaca;* Artocarpus *incisa ;* Berberis *vulgaris*, intirely fail us in performing their necessary offices.

Monstrous flowers are of no value for the botanist, as their sexual organs are wanting, and he is not capable without these to fix the genus. They may only be of some importance to him, if they ellucidate any points in Physiology. Florists value them, more especially amateurs, for they have acquired so unnatural a taste, as to despise nature in its simplicity, and with care often transplant these deformities into their gardens.

The deformities in flowers are the following:—Flos *multiplicatus*, a double flower; Flos *plenus*, a full flower; Flos *difformis*, a deformed flower; and lastly, Flos *prolifer*, a proliferous flower.

§ 334.

Flos *multiplicatus*, a double flower, is the beginning of a full flower. Flowers are styled double, when their petals exceed the usual number, but stamens and pistil still remain to do their offices during impregnation, and to produce ripe seeds. The first beginning of a double flower is the corolla *duplex*, or *triplex*, where the corol becomes double or treble. Monopetalous corols are often double, for instance, Datura; Campanula; but polypetalous corols still more frequently. As long as the pistil remains perfect in a flower, and it can bear seeds, so long the flower is called double. The cause of this deformity is the same as in the following. Very little care is taken to remedy this evil, as gardeners, even like to see full and double flowers. But if botanists wish to see double flowers of herbaceous plants restored to their natural and former state, they ought by all means to give them by degrees worse and worse soil.

§ 335.

Flos *plenus*. A full flower is that where the petals have become so numerous as to have excluded both stamens and style altogether. As such flowers want the necessary organs for impregnation, they will never be able to produce seeds. A full and double flower originates from too great richness of soil only. Numbers of vessels become stuffed, as it were, with nourishing sap, in a manner that the petals and stamens split and become divided into more petals. Some flowers are so full that the calyx bursts.

Monopetalous flowers are rarely full, such as Primula; Hyacinthus; Datura; Polyanthes.

Polypetalous plants are oftener full, as Pyrus; Prunus; Rosa; Fragaria; Ranunculus; Caltha; Anemone; Aquilegia; Papaver or Paeonia, and many others*.

§ 336.

Flowers which have nectaries in form of a spur or a cup, usually increase the number of the spur or cup alone, and lose the petals altogether, or they retain the last in their natural situation. Or they lose sometimes the spur or the cup, and enlarge only the petals.

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* Dianthus *Caryophyllus* and Papaver *somniferum* have been brought forward as fair instances to prove, that full flowers may produce seeds. But this is a mistake, a full flower having been taken for a double one. The last may bear seeds, but a full flower is totally incapable of it.

Of the first kind Aquilegia *vulgaris;* Narcissus *Pseudonarcissus*, may serve as instances. In the first the petals are completely annihilated, and the spur only increased in number. In this case, then, many spurs are inclosed in one another like so many paper bags. In Narcissus the petals remain natural, but the nectarium is multiplied.

The same plants likewise present instances of the second kind; in Aquilegia, the spurs are in this case entirely wanting, and the petals increase in number; in the same way Narcissus may sometimes want the nectarium, and the petals become full. The violet and the larkspur become full, like those two.

§ 337.

Flowers which have one or a few stamens only, will seldom be full. When it happens, it is only in such plants as have a monopetalous corol. As an instance of this kind, I shall mention Jasminum *Sambac.* Some of the natural families never yet produced any double or full flowers. Such are,

Palmae, (§ 143, 1).
Mosses, (§ 143, 56).
Algae, (§ 143, 57).
Filices, (§ 143, 55).
Fungi, (ib. 58).
Calmariae, (ib. 3).
Gramina, (ib. 4).
Apetalae, flowers without petals.
Amentaceae, (ib. 50.)
Tripetaloidae, (ib. 5.)

Orchideae, (§ 143, 7.)
Scitamineae, (ib. 8.)
Oleraceae, (ib. 12.)
Inundatae, (ib. 15.)
Bicornes, (ib. 18.)
Tricoccae, (ib. 38.)
Stellatae, (ib. 47.)
Umbellatae, (ib. 45.)
Asperifoliae, (ib. 41.)
Verticillatae, (ib. 42.)

Some of the last, however, afford an exception. In those flowers which are styled Personatae, (§ 75, 13), it has been only observed in the species Antirrhinum. The papilionaceae, (*l. c.* 32), have been found full in a few instances only, as in Coronilla, Anthyllis, Clitoria, Spartium.

§ 338.

Full flowers, as we have just now mentioned, occur most frequently in polypetalous corols, but the monopetalous are sometimes seen full, though this was formerly denied. Instances are, Colchicum; Crocus; Hyacinthus; Polyanthes; Convallaria; Polygonatum. The polypetalous corol becomes full by its petals, the monopetalous by their laciniae.

Full flowers are somewhat of the appearance of compound flowers, and may therefore easily be taken by the student for such; but they are easily distinguished by the following marks: 1. In the centre of a full flower remnants of the style are still to be seen. 2. Each petal is not furnished with stamens or a style. 3. After they have blossomed, nothing remains, and no fruit whatever can be traced. 4. Lastly, no common receptacle is to be found.

§ 339.

Compound flowers become full in a peculiar manner. *Flores semifloſculosi*, when they grow mature, have a very long germen and a pappus, which is as long again as the germen. The linguiform corol, style and stamens are natural, but the stigma is divided, and of the same length with the corol. Such deformities occur in Scorzonera, Lapsana, and Tragopogon.

By these characters, and that they never bear ripe seeds, they may be distinguished from natural semifloscular flowers.

§ 340.

Flores radiati. Radiated flowers, grow full in a two-fold manner, either by the disc or centre, (*discus*), or by the rays, (*radii*). If the disk is full, it annihilates the radii altogether, and the tubular corols grow longer, so as to get almost a club-shaped form, and in this case the stamens are entirely lost. Instances are, Matricaria, Bellis, Tagetes, &c. In the same manner, likewise, compound flowers become full, which naturally consist of tubular florets, for instance, Carduus.

From natural flowers of the same external appearance, full flowers may be easily distinguished by the longer corol, and by the want of seeds.

If the radius is full, then no disk can be seen, and such a flower gets much of the appearance of the flos semiflosculosus, from which however it may be distinguished at once, by there being not the least appearance of stamens. From the simple full flower the full compound flower differs in this point, that there is a style attached to each petal. The radius of a simple radiate flower remains the same in a full radiate flower. If the radius is beset with prolific female flowers, then the full flower, consisting of mere linguiform flowers, is provided with prolific styles, and may without difficulty, if there be any natural plants in its neighbourhood, come to bear ripe seeds. If the radius, on the contrary, consists of barren female flowers, we commonly find them to be the same in the full flower.

§ 341.

Flos difformis, the deformed flower, is not a full, but a barren flower, which in its appearance is unlike the natural plant. It occurs most commonly in monopetalous flowers. Some of the labiate and ringent plants especially, belong to this kind, for instance, Ajuga, Mimulus and Antirrhinum. They grow sometimes longer than usual, assume the form of egg-shaped corols, which are narrower at the top, and divided into four lobes: several long spurs are protruded from their base, which in these flowers are distinguished by the particular name of *Peloria*. The Antirrhinum *Linaria* very often affords this variety.

Another species of deformed flower is the Snowball, (Viburnum *Opulus*). This shrub has, in its natural state, small campanulate flowers, which on their margin are surrounded by large, unfertile, and rotate flowers. In gardens, and in rich soil, all the flowers grow into large rotate corols, which are three times the size of the natural corols. All the stamens and styles vanish of course. These flowers are seen in almost every garden.

Another kind of deformed flower has been observed, though extremely rarely. In one of the Umbellatae, just beneath the umbella, a compound flower was found resembling that of Bellis *perennis*. (Cf. Botanical Magazine, I. Plate 2.) A flower like this was found by Gessner on a ranunculus, (Cf. *Joan. Gesner*, *Dissert. De Ranunculo bellidifloro*, Tiguri. 1753, 4°.) It is a striking phenomenon to meet on the stem of a flowering ranunculus and of an umbella, the flower of the Bellis. Once it was thought, that the stems of both were grown together, and that the stem of the Bellis had grown and unfolded itself in the first like a grafted sprig. But late observations have shewn, that this flower is not the perfect flower of the Bellis *perennis*, but merely something like it. It is a congeries of many flowers of the ranunculus or umbella, imperfectly unfolded, which have retained their small size and yellow colour, and are inclosed in a number of whitish petals. May not the bite of insects produce this deformity?

§ 342.

§ 342.

Flos prolifer. A prolific flower is that where one flower is contained within another. This mostly occurs in full flowers. They are of a double kind, according as they are found in simple, or in compound flowers.

In simple flowers, a stem rises from the pistil, which buds and flowers. This stem is scarcely ever covered with leaves, and seldom more than one flower grows from another. Instances of this kind are, the pinclove, the ranunculus, anemone, roses, the Geum *rivale*, and Cardamine *pratensis*.

This deformity, however, is of a different kind in compound flowers. For in them a number of stems rise from the receptacle, which all bear flowers. As instances of this deformity I shall name, Scabiosa, Bellis, Calendula and Hieracium.

In the Umbellatae something similar has likewise been observed, to wit, one umbel growing out of the other, or, what I once myself saw in Heracleum *Sphondylium;* the tall stem had on its extreme points green leaves and small umbels.

Prolific flowers are a great curiosity, but they never have perfect seeds. I saw it only once in a lemon, on the apex of which a stem rose with another lemon. I doubt indeed if there be any prolific fruits, the lemon excepted.

In such fruits, however, when the common receptacle grows larger, an appearance like that of prolific fruits is often met with. Thus have I repeatedly, in the Pinus *Larix*, met with a prolific strobilus. I have indeed seen a strobilus which produced a sprig, on which other strobili were formed. In the same manner prolific spikes are formed in rich soil, in Secale *cereale*, Phleum *pratense*, Alopecurus *pratensis*, and the like.

§ 343.

A very remarkable monstrosity in the germen is, what mostly occurs in the gramina and corn, the *Clavus*. The seed becomes swelled three times its usual size and thickness, but has no corcle. The cause of this affection is not yet known, but chiefly to be placed in a fustiness of the adducent and air vessels. There are two distinct species of it:

1. The simple clavus, which is of a pale violet colour, in its interior is whitish and mealy, without any smell or taste, and may be ground along with the sound grain, without any bad effects on the last.

2. The malignant clavus, which is dark violet blue or blackish, and internally too has a blueish gray colour, a fœtid smell, and a sharp pungent taste. Its meal is tenacious, imbibes warm water only slowly, and has no slimy appearance when kneaded. The bread, however, made of it, has a violet blue colour. When eaten, cramps, and especially the Raphania of Cullen are produced by it. Persons should therefore be warned against the use of such meal.

§ 344.

Sterilitas. We call plants sterile or barren, when they produce neither flowers nor fruits. All full, deformed, and prolific flowers, therefore, are sterile, because the stamens and pistil suffer in them. But some plants are sterile only as far as they do not produce blossoms. The cause of this may be climate, too much sap, improper soils, and ill treatment. Plants, which are transplanted from a warmer climate into a colder, bloom very rarely. An artificial degree of heat, like their natural, is therefore frequently tried, but not always with good effect. And indeed those who are totally unacquainted with the natural history of such plants, will scarcely ever succeed in that way. An instance will prove this: We know that all plants from the Cape of Good Hope require more warmth in winter than in summer, and we shall, by attending to this simple fact, certainly obtain blossoms from them. Fruit-trees, when they have too much sap, and their outer bark is too thick, have only a very thin vascular ring annually formed; the sap therefore must ascend towards the top and the boughs, and fruit-trees of that kind grow often without ever having blossoms. Gardeners try to remedy this, by lopping some boughs, cutting off part of the root, and by removing the plant to a sterile soil; but they are, notwithstanding all these precautions, often disappointed. It is a surer method to bleed or scarify such trees, as it has been called, or to scratch superficially, and in a winding direction, their stem and principal branches. The vascular rings are then at freedom to expand, and the tree will most probably bloom and bear fruits without delay, as the circulation of the sap does not now go on with equal rapidity

pidity as before. Improper soil often favours sterility. If succulent plants, for instance, Cactus, Mesembyanthemum, be placed in rich garden earth, they may grow in it, but scarcely ever, at least very rarely, bear blossoms. Are they, however, placed in a ground mixed of loam and sand, then they will easily shew their blossoms, if they are rightly treated. Ill treatment indeed suppresses in many a plant the approaching flower. Amaryllis *formosissima*, if kept constantly in pots, filled with garden-earth, produces many leaves, but no flowers. But, if its bulb be taken out and preserved in a dry place, out of ground, during the winter, a flower will appear every year. Many other bulbous plants, which grow in sandy plains in warm climates, do the same. Instances would be superfluous.

§ 345.

Abortus. If flowering plants, which are provided with perfect female organs of generation, do not bear fruit, abortion has taken place. This depends on a want of male organs of generation, or a vitiated structure of the separts, violent storms, on various disorders, too great age and too much sap. Every botanic garden can shew us numberless instances of abortion. How often do we lose exotic plants, bearing no seeds, because the male organs are either wanting or in an imperfect state! How often might insects, could we obtain proper species, do this office! If there is not sufficient warmth, which is so often required, to ripen a foreign fruit, this must necessarily drop off in its immature state.

Drought

Drought and sterile soil not unfrequently deprive us of the fruit which we expected. Careful watering may assist us here greatly. The larvæ of various insects, and often these themselves, when perfect, rot and destroy the fruit. Winds, old age, and accidents, often disappoint our hopes of gathering fruit. Here no remedies are of avail, except avoiding the occasional causes. Finally, from too great a quantity of sap, many a fruit-tree throws off its fruit. This happens in the same manner as when plants do not blossom for superabundance of sap, and the means above in this case recommended, may serve us here as well. Most bulbous plants, when the sap accumulates, drop their immature fruit. They should therefore be planted in dry ground. Some bulbous plants indeed only then ripen their seeds, if their unripe fruit be cut off with the stem, and kept thus lying for some time.

VII. HISTORY OF PLANTS.

§ 346.

By the history of Plants we mean, a comprehensive view of the influence of climate upon vegetation, of the changes which plants most probably have suffered during the various revolutions this earth has undergone, of their dissemination over the globe, of their migrations, and lastly of the manner in which nature has provided for their preservation.

§ 347.

Geographers have divided our globe into different zones, circles and degrees. According to this division they believe, that under the equator or the line, the hottest climate is to be found; under the tropics, a warm climate only; and between the tropics and the polar circles, a moderate and cold climate; that lastly, under the polar circle a frigid climate prevails. In general those divisions are pretty just, but mountains, valleys, rivers, marshes, forests, seas, and varying soil, often make a remarkable difference, so that some places which, according to the above divisions, should be warm, belong to the temperate or even cold climates, and *vice versa.* Hence we must make a careful distinction between the geographical and physical climate. America and Asia, though in some parts of the same northern latitude with us, are much colder. Plants which in America grow under the 42° northern latitude, bear our climate of 52 degrees very well. The reason of this great difference appears to be, in America, the immense marshes and woody tracts; in Asia, the much more elevated and mountainous situation of the country. Africa is much hotter under the tropics, than Asia or America in the same situation. But in these last countries, immense chains of high mountains, and moist ground, moderate the great heat, whereas, on the contrary, the hot sands, of which Africa almost entirely consists, increase it. The countries about the North Pole are much more temperate than those of the South Pole. The Tierra del Fuego, situated under 55° southern latitude, has a much colder climate than Europe under 60°. High mountains, which with their lofty summits enter even the cloudy regions, have, in all latitudes of the globe, their highest points covered with ice. Cook detected such a high mountain in the Sandwich islands, and in America, the Andés, as they are called, under the tropics, are eternally covered by ice, whereas in the valleys beneath, a constant summer reigns.

§ 348.

Soil, situation, cold, heat, drought, and great moisture, are all of powerful influence upon vegetation. Nobody will wonder, therefore, to find in every quarter of the globe, plants almost solely destined for these situations. If therefore we find the plants of the countries within the polar circles on high elevated mountains, we at once conclude that those plants grow in cold countries chiefly. And it is as little surprising to meet in America, Asia and Africa, in plains of the same latitude, plants of the same species, belonging in common to the three parts of our globe.

In a geographical latitude, different parts of the globe may, provided that mountains or other circumstances produce no changes in the temperature, produce the same plants, but in places of the same longitude different products must necessarily always appear. Brandenburg, the coast of Labrador, and Kamtschatka have nearly the same latitude, and indeed have many plants in common with each other. Berlin, Venice, Tripolis and Angola, though nearly of the same longitude, differ very much in their vegetable productions.

§ 349.

We learned, when treating of the Physiology of plants, how indispensably necessary warmth was for vegetation. Hence it follows, that the warmer the climate, the greater must be the number of wild growing plants. The Floræ of different parts of the globe, with which botanists have favoured us, shew indeed, that vegetation increases with the degree of warmth. In Southern Georgia, according to credible accounts, only two wild growing plants are found; in Spitzbergen, 30; in Lapland, 534; in Iceland, 553; in Sweden, 1299; in Brandenburg, 2000; in Piemont, 2800; on the coast of Coromandel, about 4000; in Jamaica as many, and in Madagascar nearly 5000. Plants grow almost everywhere, except in the cold countries near the poles, on summits of the loftiest mountains, both eternally covered with ice; and the dry sandy deserts of Africa. In barren and naked countries, which perhaps have been laid waste by immense volcanic eruptions, for instance, in the island of Ascension, at Kerguelen's land, &c. few plants are found.

§ 350.

Climate influences greatly the growth of plants as well as their formation and shape. Those, therefore, peculiar to the polar regions and high mountains are low, have very small compressed leaves, and often in proportion very large flowers. European plants have rarely very beautiful flowers, and many are amentaceous. Asia mostly produces the greatest beauties, whereas Africa, on the contrary, has plants with very thick and succulent leaves, and variously coloured flowers. American plants are generally remarkable by their very smooth and long leaves, and a singular shape of the flowers as well as of the fruit. Those of New Holland, on the contrary, have mostly small dry leaves, and a more shrivelled appearance. Those which grow in the Archipelago are, in general, shrubby and provided with prickles. In Arabia almost all plants are low and grow in a very decrepid form. In the Canary Islands those put on the appearance of shrubs and trees, which in other countries occur as herbs only.

There is a striking resemblance between the trees and shrubs of the northern parts of Asia and America, whereas the perennial plants, herbs, and undershrubs of both countries, do not in the least correspond with each other in their form. The following list will however prove the above similarity :

In North Asia grow,	*In North America,*
Acer *cappadocicum.*	Acer *sacharinum.*
—— *Pseudoplatanus.*	—— *montanum.*
Azalea *pontica.*	Azalea *viscosa.*
Betula *davurica.*	Betula *populifolia.*
—— *Alnus.*	—— *serrulata.*
Corylus *Colurna.*	Corylus *rostrata.*
Crataegus *sanguinea* Pall.	Crataegus *coccinea.*
Cornus *sanguinea.*	Cornus *alba.*
Fagus *sylvatica.*	Fagus *latifolia.*
—— *Castanea.*	—— *pumila.*
Juniperus *lycia.*	Juniperus *virginiana.*
Liquidambar *imberbe.*	Liquidambar *styraciflua.*
Morus *nigra.*	Morus *rubra.*
Lonicera *Periclymenum.*	Lonicera *sempervirens.*
Pinus *sylvestris.*	Pinus *inops.*
—— *Cembra.*	—— *Strobus.*
Platanus *orientalis.*	Platanus *occidentalis.*
Prunus *Laurocerasus.*	Prunus *caroliniana.*

Rhododendrum *ponticum.*	Rhododendrum *maximum.*
Rhus *Coriaria.*	Rhus *typhinum.*
Ribes *nigrum.*	Ribes *floridum.*
Rubus *fruticosus.*	Rubus *occidentalis.*
Sambucus *nigra.*	Sambucus *canadensis.*
Styrax *officinale.*	Styrax *laevigatum.*
Thuja *orientalis.*	Thuja *occidentalis.*
Tilia *europæa.*	Tilia *americana.*
Ulmus *pumila.*	Ulmus *americana.*
Viburnum *orientale.*	Viburnum *acerifolium.*

&c. &c.

Between the shrubby plants of the Cape of Good Hope and New Holland a great similarity likewise prevails. May not a certain correspondence of the soil or the situation of these countries, at the time when organic bodies were beginning to be formed, have produced this great similarity?

In cold climates a great number of cryptogamic plants are found, especially fungi, algae, and mosses, Tetradynamic plants, Umbellatae, Syngenesiae, and, in general, few trees and shrubs. In warm climates, on the contrary, trees and shrubs, filices, twining under shrubs, parasitic plants, lilies, Scitamineae, (§ 142), are in greatest abundance. Herbs, perennial and annual, grow there during the rainy season only. Pinnate and nerved leaves occur more in those warm countries than in others.

Aquatic plants have, as long as under water, fine filiform leaves, which, however, as soon as they reach the surface, become broad, round, and at their base more or less laciniate.

Plants which grow on hills, are, with regard to the shape of their leaves just the reverse, if compared with aquatic plants, for their radical leaves are more or less entire and undivided, but the leaves on the stem become the more minutely intersected the higher up they are fixed to it. We find this, for instance, in the Scabiosa *columbária*, Valeriana, and others.

§ 351.

Plants, as long as they remain in their natural uncultivated state, retain mostly the same character, though sometimes they produce varieties. Those, however, do not occur so frequently as in plants which have been long cultivated by art. It is singular indeed that animals when tamed, and plants when they have undergone the various management of art, easily change in form, colour, and taste, (§ 203).

Alpine and polar plants grow larger in valleys or gardens; their leaves gain in length and breadth, but their flowers are smaller, at least they do not grow larger like the rest of the plant. Plants of warm climates often change their appearance so much, that a pretty good practical botanist would scarcely be able to recognize them in their native countries. The varieties of our species of fruit and oleraceous plants are innumerable.

§ 352.

Now, how does it come that our globe produces such an immense number of plants? Were all produced when it was first formed, or did those new species originate at later periods, and in succession from a commixture of different genera? These questions will scarcely ever be answered in a satisfactory manner. Linné and some other botanists think, that in the beginning there were genera only, by a commixture of which afterwards species were produced, which again in the same manner gave rise to other subspecies. But this is scarcely to be admitted; for in that case, even in our days, such commixtures of various genera would give birth to new species, and this certainly would be noticed by philosophers. If that Infinite Power, which to the whole universe gave its existence, formed different genera, why should it not have created the species? All in nature is harmony, and one thing is dependent on another, like the most compound mechanism. No doubt, therefore, that the great Author of things created most of our plants, as they now are. Perhaps some genera of plants, numberless species of which exist in one country, have, one or another, produced their species, by commixture of each other. We find, fo rnstance, at the Cape of Good Hope, of the genus Erica more than a hundred species; of Ixia and Gladiolus, about 40; of Protea, 62; and of Mesembryanthemum near 100; not to mention many other genera there, full of species. The great likeness of some of them, which makes it often very difficult to point out a distinguishing character, seems to prove this still more.

That prolific hybrids are not a very extraordinary phenomenon in the vegetable kingdom, we had an opportunity of observing before, (§ 298). We often see them produced in our gardens, and cannot therefore deny the possibility of their generation in open air. But nature has wisely guarded against too easy a commixtion of such plants in their uncultivated, free state. For we often find plants of the greatest likeness in parts of the globe very distant from each other, and at very different periods, and in different places in blossom. Plants of great likeness and similarity only can be mixed and produce a hybrid offspring. Hence such a commixture never happens where only few species of the same genus grow in one climate. One instance will sufficiently explain this: three species of Scrophularia grow wild about Berlin, to wit, Scrophularia *verna*, *nodosa* and *aquatica*. The first grows in villages, about hedges, and blossoms in spring. The second grows in moist meadow ground, near ditches, and blossoms a month later. The last grows in rivers, rivulets, marshes, and ponds, and flowers more than four weeks later than the second. Other species of the same genus, and very like those three, grow in Italy, Siberia, in the East, North America, &c. In all those, no hybrids can be formed in their natural state. But were we to place in a botanical garden all the species, foreign as well as indigenous, in on espot, no wonder if the very different climate and soil, which would probably disagree with many species, would bring the flowers out sooner or later than natural, and that swarms of insects, flying from species to species, might, against our will, give rise to bastard productions, which in a natural state could not have happened. We will certainly by and by get acquainted with some plants which are never found originally growing wild, but owe their existence entirely to the botanic garden.

Our numberless varieties of fruit, we owe undoubtedly to some kind of bastard generation, and many of them, which we consider as proper peculiar genera, are perhaps only such preternatural hybrids. I do not think it, therefore, at all improbable, that Pyrus *dioica*, *Pollveria*, and *prunifolia*, owe their existence to such circumstances.

§ 353.

But even should it remain uncertain, whether some plants have arisen entirely from a commixture of various species, we may perhaps, from the observations hitherto collected on the subject, be enabled to make a more certain conclusion, with respect to the former state of our globe, and the probability that great revolutions have taken place in the vegetable world.

Various, and often very fanciful ideas, have been formed by philosophers, on the origin of our globe, and the changes it has undergone. Every one supposes he has given a true explanation, but upon the whole, we have not come nearer the truth. And indeed we will never have the satisfaction to form a true idea of the formation of the earth, nor ever be able to fix the periods with certainty, when all the great revolutions in it happened.

For our purpose it will be sufficient to know, that such immense changes took place in our globe, and necessarily had a powerful influence upon the vegetable world. In northern countries, where the cold is so great that no trees can grow, and a few small shrubs with difficulty shoot forth, we find whole strata and beds of coal, which, as we certainly know, are vegetable productions. In those countries, therefore, forests certainly were once in abundance, where now there are none. In the same manner, bones of the elephant and rhinoceros are dug up, though these animals could not now live in our cold climate. We find in our slate clay, impressions of filices, seeds, and palmae, which do not occur in our country. About Wettin, near Halle, (in Upper Saxony), a great number of those impressions in slate clay are found, in which the species of several filices can be recognized, which at present grow all in the West Indies only. Of some impressions the originals have not yet been detected. It would be superfluous to mention here the great number of shells which we find, without knowing the recent species.

It is only in flat countries and upon floetz mountains, where these respectable remnants of past times are met with, and never in primitive rocks. But not only are the products of warm climates with us often found buried in the deepest ground, bones of animals of the coldest regions are likewise found. And the products of both countries are often mixed together. Hence we cannot say that the warm climate once was extended farther to the north; that our globe changed its situation towards the sun, or that the axis of the earth was changed to its opposite point; these are all the speculations of a fanciful genius. But we need not torment our minds with hypotheses, formed in the study, and refuted almost by every newly found petrefaction. Perhaps nature herself, as we see her now, after many changes and revolutions, will throw light upon those inexplicable facts. Perhaps we may some time be able to see the order in which these revolutions happened, though not to fix their precise periods, which probably far exceed our received chronology.

In plains, which contain a number of sea productions, and in floetz mountains, which have the petrefactions of the continent, and of the seas of various zones, we meet with plants, which bear seeds, and send their roots deep into the ground, as if they had grown there for ages. But experience tells us, that they could not have originally grown at those spots. In the primitive mountains only, we may suspect that every thing remains unaltered, as their foundations never suffered from the gnawing tooth of time.

We find that mountainous countries are richer in plants than flat countries, and that in primitive mountains the number of plants exceeds that of the floetz mountains. A country consisting of primitive rocks has plants which other mountainous countries do not possess. In all plains of the same latitude, however far they may extend, the same plants always occur, only with some little varieties, which depend on the difference of the soil. In primitive rocks, and at their foot, we again meet with all the plants of flat countries. Wherever primitive rocks surround a plain country, we find all the plants of this at their root and even at their summits. But after ascending and descending on the opposite side, we find a different vegetation, which again extends as far as the next mountainous chain. The lists of plants of the different countries of Europe and other parts of the globe will be of great service to us to prove this fact. Now, who will doubt, that all the plants of flat countries, which were formed at a later period, came from the high mountains, and that the primitive mountains of our globe, were the chief sources, as it were, of the floras of different countries. Hence America is so full of plants, because from the North Pole to the South, high mountainous chains, with numberless intermediate branches, intersect it. Hence Canada produces different plants from Pennsylvania, this again from Virginia, this again different plants from Carolina, and Carolina from Florida, &c. Hence the north-west coast of North America produces plants which totally differ from those of the north-east coast, the south-west coast different plants from those of the south-east. Islands which are quite flat, have all the plants of the neighbouring continent, but if they are surrounded by high mountains, many quite peculiar plants are to be found in them.

It would appear from these facts, that the vegetable kingdom did not suffer materially from all those very violent catastrophes. Perhaps those changes took place only gradually, and several thousands of years, if not more, elapsed before all things came to that state, in which we find them now. Most likely our posterity will gaze at similar changes in a future period, which nature is now slowly preparing. Nature is always changing, always operating, and often at a very late period only we experience the effects of those changes and operations.

§ 354.

But before all this took place, was not the sea of far greater extent than at present? Perhaps our earth then was one sheet of water, interrupted only by ranges of lofty mountains, and the depth of the sea itself less. Vegetation only existed upon these summits. The sea worked gradually deeper in the ground, and the mountains became lower, and thus gradually the continent was formed, on which now the plants of the mountains and those in their valleys became disseminated. Here and there the sea left large lakes of sea water, which were gradually evaporated, and left the firm fossil-salt behind. Waves or storm winds covered these beds of fossil-salt with earth or with mud, which finally became hard and stony. The sea shores nourish plants, we know, quite peculiar to them, which only agree with saltish ground, and decay in ground which contains no salt. Those plants of the sea-shore, near beds of fossil-salt, find food enough, and propagate themselves. Subterraneous springs of sweet water flowed over those salt beds, dissolved part of the salt, and came out from the ground as salt water springs. Here likewise the plants of the shore got food enough, and grew plentifully. This appears to be the true origin of salt-springs, and explains why in their neighbourhood the plants of the sea shore are met with. We find still in the centre of the continent near salt-springs the following maritime plants, which occur in no other place, viz. Salicornia *herbacea*; Poa *distans*; Plantago *maritima*, *subulata*; Glaux *maritima*; Samolus *Valerandi*; Aster *Tripolium*; *acris*, and many others.

§ 355.

Most probably the continent was formed in the manner just now described. The different products of sea, lying on the shore, were buried deeper by the constant play of the waves, which here and there even raised hills of not inconsiderable size, which hills perhaps in time, in proportion to the earths mixed with them, and, according to circumstances, became a hard lapideous mass. After this, during a long series of years, the continent rose in its present form, violent gales of wind, and the violence of other furiously raging elements, volcanoes, and the like, again tore large masses from it, formed islands, or carried whole masses of that kind with their productions into remote regions. Thus perhaps many of the exotic natural productions in our climates were buried in the ground, which we now find in solid rocks, in petrefactions or impressions. That the currents in the ocean can convey natural productions to very distant parts of the globe, experience shews us. For many seeds of West Indian plants are still thrown on the shores of Norway.

But under what circumstances these probable revolutions took place, or during how many hundreds of years, are questions which are out of the sphere of our present researches, and perhaps will never be clearly and decidedly answered.

§ 356.

It is not improbable, that during such great changes, some single productions were entirely lost. We have, for instance, in the animal kingdom, found several petrefactions, of which the originals remain still unknown, and of plants some which, as we now well know, are found at a particular spot of the globe only. These circumstances seem to prove, that some violent catastrophe happened in their propagation, by which even perhaps some were lost. Thunberg discovered at the Table Mountain of the Cape of Good Hope, in a single spot only, Disa *longicornis*, and Serapias *tabularia*, but never afterwards any where else. Tournefort found on a single rock only of the small island Amorgos in the Archipelago, the Origanum *Tournefortii*. Sibthorp, who succeeded him in the same voyage, met with it on the same spot, and no where else.

Countries, now separated by the ocean, were in former times most probably joined, at least we may suspect this from the different natural productions which both have in common. Thus New Holland may have been joined to the Cape of Good Hope; and Norfolk island with New Zealand. For in New Holland some plants of the Cape of Good Hope are found; and New Zealand, which has quite a different Flora from that of the neighbouring continent of New Holland, possesses most plants which Norfolk island has. The Phormium *tenax* in particular grows in both. Several other observations like this might be made, would our present limits permit it.

§ 357.

Besides the manner, just now noticed, in which plants probably were disseminated over our globe, many circumstances contributed to disseminate them still more, than would otherwise have happened.

Several seeds are provided with a kind of hooks, by which they adhere to the skin of animals, and thus are carried about. Birds seek for different seeds, and often carry them to the distance of miles. The seeds of several aquatic plants become glued, as it were, to the feathers of water-fowls, and again are washed off when these birds visit other water.

The seeds of most plants, when perfectly ripe, sink to the bottom in water. If inclosed in a hard shell, they will for a long time remain fresh. Several feet under ground, or at the bottom of the sea, seeds remain long fit for germination. Air has no access to such depths, and therefore does not destroy the seeds. Hence it is that rivers and seas may carry seeds from very distant regions. On the shores of Norway, (§ 355), ripe and fresh seeds from the West Indies are often thrown out. Did that climate suit those seeds, we would soon find the Cocos *nucifera* and other plants of the warmer climates germinate there and grow up. The seeds of the Cratægus *torminalis* are conveyed far by our rivers. Many German plants are found on the shores of Sweden. Several Spanish and French plants on those of Great Britain; many African and Asiatic plants are met with on the coasts of Italy. The wind likewise carries those seeds which are provided with a pappus, with wings, or with membraneous margins, as well as the capsules of seeds extended by air, that they may germinate in far distant places. For this reason several plants which possess very light seeds, have been far disseminated in the very direction the wind had mostly blown, and to greater extent, than it would have happened without the aid of the wind. The winged seeds of the birch, (Betula *alba*), are often carried by winds to the top of high steeples, and the lofty summits of rocks, where they not unfrequently germinate. The birch, therefore, on account of the lightness of its seeds, is disseminated all over the north of Asia, where the heavy seeds of the oak, (Quercus *robur*), cannot follow.

Some seed capsules and fruits burst with a degree of elasticity which forces the seed round to some distance, whereas others, on the contrary, can only remain in the neighbourhood of their original abode, especially all those that ripen under ground. The pistil of some plants sinks after the blooming is over, into the ground, and there attains its maturity; instances of this are, Arachis *hypogaea;* Glycine *subterranea;* Trifolium *subterraneum;* Lathyrus *amphicarpos;* Vicia *subterranea.* Berries, and all the more fleshy fruits, cannot disseminate themselves; they fall to the ground, and their juicy integuments present the necessary food to the young plants. Several birds and other animals feed on them, carry them off, tear the fleshy part, and thus drop the seeds, or these pass indigested through their intestines, and thus are spread abroad. In this manner Viscum *album* is propagated by a bird, Turdus *viscivorus*, and Juniperus *communis*, and others in like manner.

Man, however, more than wind, weather, seas, rivers and animals, contributes to the dissemination of plants. He who commands nature, who changes deserts into beautiful landscapes; lays waste whole countries, and again brings them to their former state, has in various ways favoured the distribution of a number of plants over our globe.

The wars in which different nations have been engaged, the migrations of nations, the crusades, the travels of different merchants, and commerce itself have brought a number of plants to us, and transplanted ours into foreign countries. Almost all our culinary plants come from Italy or the East, as well as most species of corn. Since the discovery of America, likewise, we have got several vegetables, which formerly were not known, but now are universally spread over Europe.

The common thorn apple, the Datura *Stramonium*, which now grows almost throughout all Europe, the colder Sweden, Lapland, and Russia excepted, and is thrown out as a noxious weed, came from the East Indies and Abyssinia to us, and was so universally spread over Europe by a set of quacks, who used its seeds as an emetic or cathartic.

The Phaseolus *vulgaris* and Phaseolus *nanus*, the Impatiens *Balsamina*, and the Panicum *miliaceum*, were brought to us from the East Indies.

Buck-wheat, and most species of corn and peas, we have received through Italy from the East.

Apples, pears, plumbs, sweet cherries, (Prunus *avium*), the Mespilus *germanica*, Cratægus *torminalis*, and hazel-nuts, are originally natives of Germany. In warmer countries they only improve in taste. Their different varieties, and the rest of our fruit, we have obtained from Italy, Greece, and the Levant.

The horse-chesnut, (Aesculus *Hippocastanum*), was, through the care of Clusius, first conveyed from the north of Asia to Europe in the year 1550. The Fritillaria *imperialis* was brought to us first from Constantinople in the year 1570.

After America was discovered, many plants were imported, and grew in our climate. The potatoe was first described by Caspar Bauhin in 1590, and Sir Walter Raleigh, in the year 1623, distributed the first which he brought from Virginia, in Ireland, whence all Europe got them.

The Oenothera *biennis* was introduced by the French in 1674, on account of its eatable root. Since then, it has become so common in Europe, that it grows almost everywhere near hedges and about villages.

The tobacco, (Nicotiana *tabacum*), was first described by Conrad Gessner in 1584. In the year

1560

1560 it was imported into Spain, and by Nicot, a French ambassador, into France in 1564.

Cabbage, and other oleraceous vegetables, came with the Greeks to Rome, whence they were distributed over Italy and the rest of Europe. To describe the migrations of all our cultivated plants, would cost us too much time; to have mentioned the most remarkable ones, I suppose, will be sufficient.

Along with the different species of corn, wheat, and the like, various plants were imported, which are now considered as indigenous. Such are, Centaurea *Cyanus*; Agrostemma *Githago*; Raphanus *Raphanistrum*; Myagrum *sativum*, and others. These grow among corn only, and never in uncultivated spots. In the same manner in Italy many East India plants, which grow among rice only, have become natives there, by the cultivation of rice. This plant has been cultivated in Italy since the year 1696.

The Europeans have, wherever they settled in foreign parts of the globe, planted our culinary vegetables. Thus many European plants have got to Asia, Africa and America, and have been propagated there if the climate was suitable.

§ 358.

Nature always takes care to use one plant for the benefit of another, and in various ways favours the dissemination and propagation of plants. In cold regions, algae and mosses serve this important purpose; but in warm countries, rain, winds, and similar changes in our atmosphere favour their growth. In our climates besides the algae and mosses, three great annual storms assist plants in their growth, viz. in spring, in the middle of summer, and in autumn. Besides their great use in clearing the atmosphere, they have a peculiar one in the vegetable world. In spring storms drive the seed, which has during winter perhaps remained dry and hanging on the stem to a distance. In summer they carry off the seeds of vernal plants which have just ripened; and in autumn those which in summer or at the end of summer attained their maturity. Moles and grubs and dew-worms soften the ground and prepare it for the reception of the seed; a hard shower pushes it deeper into the ground, where through the beneficial rays of the sun it can germinate at the proper time. How easily seeds may thus come to places, totally unfit for their reception, and how many on that account are lost, is easily conceived. Hence it appears, that the wise Author of things gave to annual plants a proportionally greater number of seeds than at the first view would appear necessary. One plant, for instance, of mays, (Zea *Mays*), has 3000 seeds; a sun flower, (Helianthus *annuus*), 4000; Poppy, (Papaver *somniferum*), 32,000; and tobacco, (Nicotiana *tabacum*), 40,320. Of so great a number of seeds, some must necessarily get to the soil they require to propagate their species.

Naked barren rocks become, by means of the wind, covered with the seeds of algae, which in spring and autumn when they ripen are, by showers, common at that season, brought to germinate. They grow up and cover the rock with variously coloured leaves, *(frons)*. After some time wind and rain bring fine dust into the clefts of the rocks, and the decayed algae themselves leave a kind of covering stratum behind. In this earth, though sparingly scattered, other seeds of mosses, which chance conveys thither, will germinate. They spread and form a fine green layer, which is soon able to lodge other small plants in its interior. The decay of those mosses and smaller plants produces, by degrees, a thin stratum of earth, which increases with years, and now even allows some shrubs and trees to grow in it, till finally, after a long series of years, where once barren rocks stood, large forests with their magnificent branches delight the wanderer's eye. Thus nature proceeds, acting by degrees, always great, constant, and intent on the good of the whole. In like manner, mosses correct and meliorate dry and barren sand. Plants peculiar to such sandy soil are almost all of them provided with creeping, spreading roots, which are very succulent, and imbibe moisture from the atmosphere. They therefore render the ground fit for the reception of algae and mosses, and thus it is converted into good fertile soil.

Mosses overspread the trunks and roots of trees, and have that peculiar property that they become very dry in warm weather, but revive through moisture. They imbibe moisture eagerly, and retain it in their interstices. They receive no nourishment from the trees, all their food they get from the atmosphere. In winter they defend the trunk against frost; in wet weather against petrefaction, and during great drought provide it with moisture, and protect it against the burning solar rays. But there is another still greater use of mosses. In them plants and trees grow as well as in the best mould. Mr Gleditsch brought several species of fruit to perfection in moss alone. Some species of moss grow particularly in marshy places, for instance, the Sphagnum *palustre*. Ponds and lakes are often quite covered with them, and by the aid of the aquatic plants growing there are transformed into meadows, pastures, and after some time into rich fields. According to Tacitus the whole Hercynian forest was once a marsh; at present fertile and rich meadows and corn fields are seen in those places described by that author. Old peasants in our neighbourhood still recollect many spots, once stagnating pools of water, now changed into gardens and meadows.

The peculiar property of mosses to imbibe a great deal of moisture, is the reason why they mostly grow in moist spots. The summits of mountains are covered with a variety of mosses, which eagerly imbibe all the moisture of the clouds around them. From the very great number of clouds which commonly assemble round the summits of mountains, and completely involve them; the mosses cannot keep all the water within them. It collects, therefore, beneath, in the clefts of the rocks, from where it runs from all sides towards the lowest part, and there finally appears as a spring. Several of those combine to form a rivulet, several of which again, swell to a considerable stream. We owe, therefore, to insignificant mosses, as they appear to be, the largest rivers, the draining of extensive marshes, and the fertility of once barren soils.

§ 359.

It is the constant plan of nature to preserve each single plant, and to use again for some further purpose every vegetable or animal organ that decays. Almost the smallest spaces serve for the habitation of an animal or plant. The richest as well as the poorest soils, the barren sand, the naked rock, the highest Alp, the deepest marsh, the bottom of rivers, of seas, and of the ocean, even the dark caverns in the interior of our earth, and the galleries of mines, possess their own peculiar plants. Putrifying animals become covered with small fungi, which still more favour their dissolution and change them into earth, to communicate manure and nourishment to other plants again. In the same manner have the leaves, stems, the wood and other parts of vegetables, an innumerable quantity of small fungi, which promote their decay. Thus then, what seems to proclaim war and destruction, is the lively scene of a little world. Every thing that is created, serves in the conservation of the whole.

§ 360.

The plants of fresh water are farther disseminated than those of the land. The water mitigates the cold and heat of climate, hence many European water-plants are found in hot climates. The Lemna *minor* grows not only throughout all Europe and North America, but even occurs in Asia. It has been found in Siberia, Tartary, Barbary, Buchary, China, Conchinchina, and Japan. The Typha *latifolia* grows in Europe, North America, in Jamaica, in Siberia, China, and Bengal. The great number of aquatic birds, which by a peculiar instinct annually change a cold clime for a warmer, are the reason of this great dissemination of aquatic plants. Most of the seeds of these ripen at the very period, when these birds leave their temporary abode. They adhere firmly to their feathers, or when swallowed by them, are not unfrequently thrown out with their excrements, entirely unaltered.

§ 361.

Those plants which grow at the bottom of the sea thrive in almost all climates, because the ocean never either becomes completely cold or warm to the very bottom, and therefore has everywhere almost an equal temperature. Fucus *natans*, a very common sea plant, which is well known under the name of sea-tang, or sea-grass, occurs under the equator as well as near both poles. As the number of various sea plants is immense, many may be found in every quarter of the globe, and the only difference is, that some require a more concentrated sea water, others a variety of soils. Others are either higher or lower in the water, but climate has no influence but upon such sea plants as occur in shallow water. It is commonly the case, that the hills or mountains under the surface of the sea, are richer in plants than the valleys and deep hollows in the bottom of the sea.

§ 362.

Alpine plants, or plants of very high mountains where these mountainous chains formerly cohered, but which since the various great changes in our globe have taken place, is not now the case, are pretty nearly the same. At least many plants may be found common to the different ranges of mountains, though each has again plants peculiar to itself. Nay, the more common mountain plants, or such as occur in the mountains of Europe and Asia, appear to follow the direction of the line of snow, as geographers call it, and are met with in Greenland, Spitzbergen, Lapland, Nova Zembla, North Siberia, and Kamtschatka in the open fields, whereas in temperate climates, they grow at the highest summits of mountains only. The mountainous regions of Siberia, Lapland, Norway, Scotland, Switzerland, the Pyrennees, Appenines, and Carpathian Alps have many plants in common with each other. The smaller mountains of Germany, of the Harz, Thuringia, Silesia, Bohemia, have many plants the same. One instance will suffice; the birch, (Betula *nana*), occurs mostly in all of them, the Alps of Siberia, the Apenines and Carpathian excepted. Does not this similarity of vegetation, though winds, birds, and other circumstances may have contributed to the dissemination of these plants, prove that these mountains once cohered? Tournefort found at the foot of Mount Ararat all the plants of Armenia; somewhat higher up, those which are common to France; still farther up, those which grow in Sweden;

den; and at the very summit the common Alpine plants, which we again meet near the North Pole. Similar observations have been made by travellers with regard to Mount Caucasus.

Swartz discovered no European alpine plants in the mountains of Jamaica, but a good number of our mosses, for instance, Funaria *hygrometrica;* Bryum *scrpillifolium*, *caespititium;* Sphagnum *palustre;* Dicranum *glaucum*, and many more. We know, that the seeds of mosses are so minute, that a single seed escapes our view, and can only be observed with a considerably magnifying microscope. Should they not, as it is certain that they are suspended in the atmosphere, have been driven there by storms, and as the climate was suitable, have germinated? At least this seems to be the only way of explaining this singular phenomenon.

But when Messrs. Forster met in the Tierra del Fuego, with Pinguicula *alpina;* Galium *aparine;* Statice *armeria*, and Ranunculus *lapponicus;* it would certainly be very difficult to say, how those plants came to such a remote quarter of the globe. Perhaps the great likeness between the European and Southern plants misled these great philosophers, though there might be distinguishing marks, which, however, the two gentlemen, firmly believing them to be our European species, did not attend to. When Linné and other botanists speak of varieties of a plant in different zones, we cannot always trust them; for I myself have very often seen, that such accidental varieties possessed even more fixed distinguishing characters, than several species differing from them, and that they really were different species. And why should nature not produce, under different latitudes and longitudes, species which are very like each other?

§ 363.

In all climates a singular diversity in plants may be observed, viz. that some are sociable, as it were, others remain always solitary; or some are never found but in great numbers crowded together, others are only singly scattered over the ground, and grow quite solitary. The reason of this singular phenomenon seems simply to be, that the seeds of such plants are either too heavy to be carried off by the wind, or that being light they are carried high up by a gentle breeze, and easily fall; or that the elasticity of their fruit capsule does not scatter them sufficiently. The roots of some plants are likewise luxuriant, and make plants grow in numbers together.

Those gregarious plants often occupy great tracts of land. Common heath, (Erica *vulgaris*), is often spread many miles. The myrtle berry, (Vaccinium *myrtillus*), the strawberry, (Fragaria *vesca*), some species of Pyrola, some Junci, and some trees belong to them. Solitary plants are, Turritis *glabra*, Anthericum *Liliago*, Lychnis *dicaio*, and others. In very populous countries, man himself changes the face of the country, by planting forests, and placing plants closer together, which originally were more solitary. The difference, therefore, between solitary and sociable or gregarious plants only strikes him in such as he does not value. To those belong principally the mosses, for which forresters and farmers care less than they ought to do. Sociable mosses are, Sphagnum *palustre*; Dicranum *glaucum*; Polytrichum *commune*, &c. Solitary, are, Polytrichum *piliferum*; all the species of Phascum, Weissia *paludosa*, and many others.

§ 364.

Plants are, like animals, confined to certain climates and latitudes. Several of warmer climates by degrees become accustomed to our climates, and even to much colder ones. The herbaceous plants, particularly, are sooner accustomed to a cold than to a temperate climate. For in cold climates, with the beginning of winter a great fall of snow mostly occurs, which does not melt before the return of spring, when no more night frosts are to be dreaded, and which is only one degree colder than the freezing point. In temperate climates, on the contrary, it often freezes very hard without the least fall of snow, and this naturally destroys all plants. Hence it is that Polar and Alpine plants with us are frequently frozen, where sharp frosts without snow are a common occurrence; whereas, these plants in their native countries are protected by the snow. Those herbaceous and annual plants of warm climates only, which want a longer period for the evolution of their sprouts and blossoms, than the short summer of cold climates allows them, or such as want a very great degree of heat, cannot be brought to live in the open air in these cold climates.

Trees and shrubs seem to suffer more in a cold climate than any other, because their perennial stem reaches far out of ground, and therefore is more exposed to the changes of the weather. Some which are natives of warmer climates have, it is true, accustomed themselves to our climate, perhaps because their cellular texture is more tenacious than that of other plants; many more plants, however, are unfit for subsistence in our climate, as their organization is not capable of suffering great changes of climate.

The most useful plants, however, have, like domestic animals, the peculiar property of agreeing with different climates; but if they are confined to certain climates, then others are found in other climates which serve the same purpose. Under the equator and the tropics, in all parts of our globe, the different species of corn cannot grow in a flat country. But then they possess rice, (Oryza *sativa*); Indian corn, (Holcus *Sorghum*); and mays, (Zea *Mays*); which they use in place of our corn. In Iceland and Greenland, on the contrary, neither ours nor the just mentioned species of corn from under the tropics, will grow. But then they have the Elymus *arenarius* in great quantities, which serves, if necessity requires it, for corn.

Eatable roots and greens never fail in any climate. Many grow wild in our country, of which we make no use, but which necessity would teach us to use, had we not got the oriental garden stuffs. Our culinary plants, (§ 357), so easily accomodate themselves to change of climate, that they have followed man into almost every zone.

§ 365.

From what has been said it follows, that after such various and manifold changes, it would be very difficult to fix accurately the point from whence each plant originally came. We shall, however, endeavour to make some general remarks with regard to the plants of our part of the globe, and their most probable dissemination, as we are better acquainted with this part, especially the northern countries, than with others. Greece only we must exclude at present, as we know nothing at all of its botany. Its flora, however, seems to come from the mountains of Sardinia, from the coasts of Asia and Africa, and from the islands in the Archipelago.

We suppose, then, that plants are disseminated from the highest mountains towards the flat countries; and, according to this supposition, establish five principal floras in Europe, to wit, the Northern Flora, the Helvetic, the Austrian, the Pyrenean, and the Apenninian Floras.

The *Northern Flora*, originates in the mountains of Norway, Sweden, and Lapland. All these nourish the same plants, which grow in the highest North. Scotland with its mountains appears to have cohered once with those of Norway, as both have nearly the same plants.

The *Helvetic Flora*, originates in the mountains of Switzerland, Bavaria, and Tyrol. The mountains of Dauphiny, as well as those in Bohemia and Siberia, are only lateral branches of the same chain. All have a great number of plants in common.

The *Austrian Flora*, originates in the Alps of Austria, Krain, Karinthia, and Steyenmark. The Karparthians are a side branch of those.

The *Pyrenean Flora*, originates in the Pyrenees. The mountains of Catalonia, Castilia and Valentia, are its branches.

The *Appenninian Flora*, originates in the Appennines, which send out many side branches.

The Helvetic Flora is dispersed farthest of all. All Germany, except Austria and Moravia; all Prussia, Poland, France, the southern parts excepted, the Netherlands and Holland, have this Flora.

The Northern Flora comprehends Denmark, Sweden and Russia, as well as a part of Great Britain.

The Austrian Flora extends from Austria through Moravia, the southern parts of Poland, Hungary, Moldavia, Wallachia, Bulgaria, Servia, Bosnia, Croatia, Sclavonia, Istria and Dalmatia.

The Pyrenean Flora goes through all Spain, the island of Majorca and Minorca, perhaps through Portugal, but this last remains still to be determined.

The Apenninian Flora extends all over Italy, Sardinia, Corsica, and part of Sicily.

If we take the lists of the plants of these five different Floras, we will find the most marked difference in them.

§ 366.

It follows at the same time, that various commixtures of these Floras, after the continent was formed and variously cohering, must have taken place. Hence is southern France where the Helvetic and Pyrenean Floras combine, so rich in plants. Hence in Piedmont the Floras of the Pyrenees, of Helvetia and the Apennines mix amongst each other, whither likewise the sea has carried many plants of Northern Africa. Hence Great Britain has partly the Northern, partly the Helvetic Flora, and in the southern extremity of that kingdom, in Cornwall, some plants of the Pyrenean Flora, on account of the neighbourhood of Spain, appear among the rest. Sweden, Denmark, and Russia have not retained the Northern Flora unmixed; they have got many plants of the Helvetic Flora. The same is the case with Germany, especially in our Brandenburgh, which has, besides the Helvetic Flora, got part of the Northern. From the last we certainly received, Malaxis *Loeselii*; Satyrium *repens*; Helonias *borealis*; Vaccinium *Oxycoccos*; Ledum *palustre*; Andromeda *polifolia*; Linnaea *borealis*. Of the Helvetic Flora we have, Chironia *Centaurium*; Euphorbia *Cyparissias*; Cucubalus *Otites*, and the greatest number of our plants.

It is a remarkable circumstance that such common plants as Euphorbia *Cyparissias*, and Cucubalus *Otites* cease to grow about 100 miles from Berlin towards the north, and that not one specimen of them can be found, though they grow very well in the botanical gardens which lie farther to the north. Perhaps these plants in time will disseminate themselves farther to the north, and they now actually spread, though slowly, in that direction. Who can say whether they may not, after many centuries, be disseminated a good deal farther, and whether other plants are not disseminated in the same way; and thus, after some years, our Flora about Berlin will have gained many plants.

Plants which are quickly propagated by seeds, and have luxuriant roots, must necessarily have been disseminated a great deal faster. And we should not wonder to see perhaps some of them disseminated all over Europe, from one end to the other, especially such plants, the seeds of which are light, and can be easily carried off by the wind, which of course have been easier disseminated than those which have heavier seeds. Such plants have wandered from Lapland to the extreme corner of Italy, nay even as far as Africa.

The Northern Asia has a great many European plants. We find towards the north the Northern Flora, towards the south the Austrian, and between them the Helvetic Flora. It appears as if at an earlier period the continent was forming round the mountains of Europe, and reaching as far as the mountains of Asia, without much land, or at least very little, having then been formed round the mountains of the northwest coast of Asia. No wonder, therefore, that as far as the Ural and the Altaic range of mountains, the flat country next to us produces few Asiatic, but mostly European plants.

North America has a great number of the smaller European plants, and principally those of the Northern Flora. Hence it appears probable, that both Europe and America were once joined, though they became afterwards separated.

§ 367.

To obtain, according to our supposition, a just idea of the dissemination of plants over our globe, it would be highly necessary to visit all high primitive mountains; to mark down accurately the Flora of each mountain, but only as far as the foot, and the narrower valleys of the Alps, not to the very flat country. Was Europe examined after this plan, we would soon be able to determine from the number of plants found, how the dissemination of them took place, what plants from this mountainous range, and what from another, found their way into the plains.

The coast of a country never exhibits to our view the plants of the interior. On the former we find many plants which have come from neighbouring countries. For this reason Asia, Africa, and America, under the tropics, have upon their coasts many plants in common with each other. But if we proceed farther into the interior, the plants first seen disappear almost entirely, and the country now shews us its peculiar Flora, which is the greater if the ranges of mountains with many branches and of very varying soil are spread far over the country. At the Cape of Good Hope we find the Flora so rich, and at the same time, so unmixed and pure, because the whole is mountainous. Madagascar is so rich in plants, because this great island is quite mountainous, and both Africa and Asia, between which it lies, have imparted their various productions to it. The Bahama islands owe their superabundance of plants to their own mountains, and to neighbouring countries. There we find, besides, peculiar plants, most of Carolina and Florida, and many from the West India islands, and of the bay of Mexico.

§ 368.

I think there is hardly one plant which originally grew wild in all latitudes. Plants, which are thus far disseminated, were so by man. The Alsine *media*, of which Linné and others think that it grows every where, is only found where it has been brought along with culinary plants. I do not find it, however, mentioned by any of the authors on the natural history of the Indies, though, I believe, it may grow there. But I doubt whether this plant would be able to propagate itself, in the hot Africa. The common nightshade, (Solanum *nigrum*), and the strawberry, (Fragaria *vesca*), are said to be far disseminated. But philosophers mistook similar plants for varieties of the common European species, and indeed considered their dissemination in by far too extensive a view. Only those plants which most commonly inhabit the coasts, are farther disseminated than those of the interior of a country. But even of them the Portulaca *oleracea*, the Sonchus *oleraceus*, and the Apium *graveolens*, are probably the only ones which have wandered very far. And indeed the two last never occur in hot climates.

I do not doubt, however, that of so vast a number of plants, there may be some which have so favourable a constitution, as to bear all climates; as in the animal kingdom, man, dogs, and swine, which agree with every possible climate.

VIII. HISTORY OF THE SCIENCE.

§ 369.

Botany, as a branch of Natural History, has only lately attained that degree of perfection in which we see it now. Though the scientific knowledge of the ancients deserves great praise, yet they were very little acquainted with Natural History. A botanist at that time scarcely deserved the name. The whole knowledge of plants consisted in a few very undetermined names, merely preserved by tradition. However, as man soon after began to feel the necessity and the utility of a better knowledge of nature, more attention was paid to this point. Especially great care was taken to fix proper appellations to the different parts of organization, and to direct the attention even of those that were not studying the science, to this important branch of natural science. After the art of printing, so favourable for science, was invented, figures of plants began to be engraved. These first drawings of plants were only cut in wood. Plants which have a striking difference from others may easily be distinguished in this way; but more delicate plants, which have some resemblance to others will scarcely ever be distinctly enough represented in figures of that kind. The best we have are from Rudbeck, Clusius, C. Bauhin, and Dodonaeus. The art of engraving in copper, became soon very important for botany. It enabled philosophers to make the knowledge of plants of more general use. The neatest plates are those of Linné in the Hortus *Cliffortianus*, of Smith, Cavanilles and L'Heretier. Some botanists gave engravings like cuts, representing only the outlines of the whole plant. Such we have in Plumier, and the works of the younger Linné. Tó·procure plates in a still less expensive manner, some botanists put printer's ink upon plants, which were dried, and then threw off the impressions. Such representations are, no doubt, very accurate, but the finer parts of the flower are always entirely lost. The best impressions of that sort we have from Junghans and Hoppe. Of coloured plates those of Roxburgh, Masson, Smith, Sowerby, Trew, and Jacquin, are the best.

Of a botanist we require in our times an accurate and thorough knowledge of all wild growing plants, from the largest to the smallest moss; a complete knowledge of all the parts of a plant, and of the botanical terms; lastly, an intimate acquaintance with all the natural families of the vegetable kingdom, and with the properties, peculiarities, and different virtues of plants. In common life we give the name of a botanist to him, who gives us good representations of plants, and knows to distinguish some by their external characters. But the first has no merit whatever, and his work can only deserve our approbation as the production of an artist, if his drawings of plants are well executed. Nor can the other pass for a botanist, as he is unacquainted with the smaller plants, such as algae, mosses and fungi. It is not the simple knowledge of plants that makes the botanist. A botanist compares his plant with all known ones, looks for the distinguishing features, and observes attentively nature in general. Nomenclature alone can indeed never afford us real pleasure, whereas careful observations will furnish us with abundant facts for further investigation. The botanist likewise points out to the physician, farmer, forrester, and artist, all useful plants, and without him they never can make any certain and just experiments.

The history of botany then shews us the gradual progress which man made in the knowledge of the vegetable kingdom. To take a view of it with more facility, we shall divide it into several epochs.

§ 370.

FIRST EPOCH.

From the first origin of the Science till BRUNFELS.

The first inhabitants of our globe were in the very beginning of their existence obliged to get acquainted with those fruits, which sufficed to satisfy their moderate desires. Experience soon taught them, that some plants were very noxious to man. Only those and the few which they used as food, were known to them. But as soon as they began to disperse here and there, and to require more necessaries, they were obliged to seek for other aliments. Several diseases, the natural consequences of a violation of the laws of nature, obliged them to look for remedies, which they luckily discovered in the vegetable kingdom, either by accident, or through animals Thus the inhabitants of Ceylon learned the use of Ophiorrhiza. A small animal, (Viverra *Ichneumon*), which feeds on poisonous serpents, eats, as soon as bitten by one of them, the root of this plant. The Ceylonese tried it, and found it an excellent remedy against such a bite. In like manner became the Americans acquainted with the use of Aristolochia *anguicida* and *Serpentaria*. Thus the knowledge of some medicinal plants commenced. The father shewed them to the son, the son to the grandson, and so forth. By tradition, the only means at those times of preserving things from oblivion, their names were communicated to the farthest generations.

In the East, at first the only seat of erudition, most care was taken to acquire a knowledge of the beneficial or noxious qualities of different natural productions. The Chaldeans communicated their knowledge to the Egyptians, these to the Greeks.

Amongst the Greeks, where indeed real science first originated, Aesculapius attempted by means derived from the vegetable kingdom to cure some diseases. But medicine soon became intimately connected with religion. In the temples dedicated to the worship of their gods, the prescriptions of Aesculapius were publicly suspended, and the priests alone undertook the examination and the search of officinal plants, and the treatment of different diseases. They were, as followers of Aesculapius called Asclepiades.

The father of medicine, Hippocrates, added to the observations of Aesculapius a great many of his own, and first published several works on medicine In his writings, the diseased and the healthy state of man are very fully treated of, and in speaking of the methods of cure, he has mentioned about 234 plants. But these are only names. Hippocrates was born 459 years before CHRIST, at the island Cos. He lived to a very old age, though the accounts differ, some saying he lived to be 89 years old, some 90, others 104, and a few indeed 109 years. The names of plants mentioned can be scarcely guessed at, for though great natural philosophers and linguists have attempted long ago to fix them properly, notwithstanding all those endeavours, they still remain very doubtful.

Cratevas or Cratejas, was a cotemporary of Hippocrates. Cratejas is said to have been very well acquainted with all the herbs and roots of Greece. His work, entitled 'Ριζοτομίκον, has been almost entirely lost, which is much to be regretted, because, most probably, the different plants mentioned in the cure of diseases by Hippocrates, were more accurately described by him. In the imperial library at Vienna some single fragments of his work are still preserved, as I am told.

Aristotle first undertook, at the expence of Alexander the Great, to write a complete natural history. This philosopher, however, has paid more attention to the rest of the kingdoms of nature than to the vegetable kingdom. He lived soon after Hippocrates.

Theophrastus was born at Eresus in the island of Lesbos about 300 years before Christ. Though he lived upwards of 85 years, he still complained of the shortness of human life. He was a pupil of Plato and Aristotle, and so great a favourite of the last, that he became the heir of his library, and his successor in the peripatetic school. Of all those which we have named, he was best acquainted with botany. In his work* he has given us the description of more than 500 plants. They are, however, only officinal plants, the use of which he has very accurately explained.

The Romans, likewise, after their victory over Mithridates, began to study this branch of natural history.

Marcus Cato wrote 149 years before Christ on medicine, and the remedies used in it.

Marcus Terentius Varro lived at the time of the emperor Augustus, and wrote chiefly on farming.

Pedanius or Pedacius Dioscorides, born in Asia, at Anagarba in Cicilia, paid extreme attention to the investigation of the medical powers of the vegetable kingdom. His work* contains the descriptions of more than 600 plants. He made many and extensive journeys through Asia. Diocorides lived under the emperor Nero, 64 years after CHRIST.

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* *Περὶ Φυτον ἱστοριας.* There are a great many Latin translations of this work; the last is Theophrasti Eresii Historia Plantarum. Lib. IX. cum commentariis J. L. Scaligeri et J. Bodaei a Stapel. Amstel. 1644. fol.

Cajus Plinius Secundus, flourished at nearly the same time. He collected the most important passages on all parts of natural history from the writings of his predecessors, but especially used the works of Dioscorides in his writings on plants. Pliny has made no discoveries himself. From his 11th to his 19th book he treats on plants. He says strangely enough, that there are many more plants growing near hedges, public roads, and in fields, but that they have no names, and are of no use. In his 56th year he became the sacrifice of his curiosity and inquiries into the nature of things, attempting to witness an eruption of Vesuvius.

Several Roman authors wrote on plants, but what they have left are merely transcripts from other authors.

The writings of some Asiatic writers, as Galenus, Oribasius, Paulus Aegineta, and some other physicians excepted, nothing more was written on the productions of the vegetable kingdom. And indeed even these authors gave us nothing else but mere lists of names, which are of no use whatever.

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* Περὶ ὕλης ἰατρικῆς, or De Materia medica, Lib. VI. It was first published by A. Manuce at Venice, 1499, in folio. Another edition was published with notes, by J. A. Saracenus, at Francfort, 1598, in folio. But we have been favoured by Van Swieten, at Vienna, 1770, with a very elegant edition with plates.

Soon after CHRIST several physicians, Mesue, Serapio, Razis, Avicenna and others appeared in Arabia. But they mention only the officinal plants of older writers.

A long pause now happened, during which science was, as it were, entirely asleep. The few scattered writings on medicine and natural history were mere compilations of old authors, decorated with the pedantic learning of monasteries. Thus botany was almost forgotten till in the 16th century a German, of the name of Brunfels, roused this science from its lethargy.

§ 371.

SECOND EPOCH.

From BRUNFELS *till* CAESALPINUS;

From 1530 to 1583.

In the last epoch, little or nothing was done in botany during a space of some thousand years. With the catalogues of about 600 plants, a foundation was laid, but no prospect whatever of the structure to be erected upon this foundation.

This second period indeed presents us with more promising views. All science begins to revive again, and monasteries are no longer the exclusive seat of human knowledge. Brunfels, Gessner, Fuchs, Dodonaeus, the ever memorable Clusius, and the great Bauhin opened the path.

Otto Brunfels, son of a cooper, was born at Maynz, at the end of the 15th century. He was first a Carthusian friar, became soon after cantor, (precentor), in Strasburg. After he had lived there about nine years, he applied with so much applause to the practice of medicine, that he got an invitation to Bern, where he practised about a year and a half with general approbation, but on the 23d of November, 1534, he died there, lamented by the whole city. In his work* he has given the first cuts, and he was also the first botanist in Germany. The drawings are not very good, and do not in the least correspond with his own descriptions.

Hieronymus Bock was born at Heidesbach in Zweybruecken, 1498. He lived there for some years, but went afterwards to Hornbach, where he became clergyman and physician at the same time. He died in the 56th year of his age, the 21st of June, 1554. He changed his name, according to the fashion of his age, to the Greek name Tragus. In three books of his work* he treated pretty accurately of those plants, which grow in Germany, and represented the described plants in 567 figures, which are not quite bad. It is an objection made to him that he neglected the virtues of the plants, though he knew them perfectly well, and that he used the writings of the ancients too little.

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* Otto Brunfels Historia Plantarum Argentorati, Tom. I. and II. 1530; Tom. III. 1536. New editions appeared in 1537 and 1539. The same work was translated into German, and published at Strasburg, 1532, in folio. The second part appeared 1537. We have, besides, an edition of it, published at Frankfort, 1546, in fol.; and one in Strasburg, 1543, in 4to. The works of Brunfels are very scarce. He has written besides something on medicine, and on the plants of Dioscorides.

Euricus Cordus was born in a small village in Hessia, and died 1538. He taught and practised medicine in Erfurt, Marburg, and Bremen. According to the general opinion, he was one of the most learned men of his age. He wrote several treatises on plants, especially those described by the ancients†.

His son Valerius Cordus was born 1515, and was unfortunately, when on his way to Rome, 1544, killed by a horse. His works‡ are rare, and the editions of Dioscorides which he published are still thought valuable.

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[*] Hieronymus Boak or Bock called Tragus, Kraeuterbuch von den vier Elementen, Thieren, Voegeln, and Fischen. Strasburg. 1546. fol. We have a Latin, new, altered German, and different new editions of the old one. This work begins to be scarce.

[†] Eurici Cordi Botanologicon, sive Colloquium de herbis. Coloniae. 1534. 8vo. His son published a second edition at Paris, 1551, in 12mo.

[‡] Valerii Cordi Historia stirpium Argentorati. 1561. fol. The famous Conrad Gesner published this work after the author's death. The figures are taken from Tragus, and only 60 are new. The Zurich edition is quite the same.

Conrad Gesner, the greatest polyhistorian of his age, was born at Zurich, 1516, and died there 1565. He has written on several branches of natural history, botany, and physic. His works are as under*.

Leonard Fuchsius was born in Bavaria, 1501. He studied at Heilbrun, Erfurt, Ingolstadt, and after many changes of fate, came as professor to Tuebingen, where he died the 10th May, 1566. The emperor Charles the Fifth esteemed him very highly, and honoured him in various ways. He wrote a history of plants, of which many editions have appeared in German, French, and Latin†, and likewise wrote notes to Dioscorides, Galen, and Hippocrates, on which account he entered into a great dispute with the famous physician and philologist, John Heynbut or Hagenbut, who likewise called himself Cornarus. Cornarus published a treatise against him, entitled, Vulpecula excoriata. Fuchsius answered in another, with the title, Cornarus furiens; after which Cornarus finished the dispute with the publication of a work,

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[*] Conradi Gesneri Enchiridion historiae plantarum. Basil. 1541. 8vo. De plantis antehac ignotis. Without a year or place. 12mo. Historia plantarum. Basil. 1541. 12mo. De raris et admirandis herbis, quae, sive quod noctu luceant, sive alias ob causas, Lunariae vocantur, Tiguri. 1555. 4to. This last is extremely scarce.

[†] Leonardi Fuchsii de historia stirpium commentarii insignes. Basiliae. 1542. fol. It has 512 figures, several of them taken from Brunfels, though larger. All the trees and smallest plants are drawn of the same size. There is another edition in 8vo: which is the first.

Mitra, *s.* Brabyla pro vulpecula excoriata asservanda.

Peter Andreas Matthiolus, a physician at Siena, was born in the year 1500, and died at Trident, in 1577, of the plague. He was a very celebrated physician, and we owe him several new medicines. He had carefully studied the works of the ancients, especially of Dioscorides. His Kraeuterbuch, (work on plants), was written originally in Italian, but we have French and German translations of it*.

Rembert Dodonaeus was born at Mecheln in 1517. He was one of the emperor's physicians, and well known for his skill, all over Germany, France, and Italy. In the year 1583 he accepted of a call as Professor to Leyden, where he died 1585. His chief work† was far superior to any hitherto published, as well for the neatness and accuracy of the cuts it contained, as for the descriptions. It contains about 1330 very good figures, part of which are taken from Fuchsius, Clusius, and Matthiolus.

Matthias de Lobel, physician to King James I. of Great Britain, was born at Brussels in Flanders in 1538, and died in London 1616. Together with Peter Pena, a physician in Provence, he wrote the Adversaria, part of his greater work. He says that this physician sent him many rare plants. Some assure us that he has in his works* given many ideal figures of plants, and that he has described several as growing wild in Britain, which after him nobody ever could find.

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* Peter Andreas Matthiolus Kraeuterbuch, (work on herbs and plants), durch Joach. Camerarium. Frankfort. 1590. fol. with 1069 figures. The first Italian edition was without figures, and appeared at Venice in 1548.

† Remberti Dodonaei stirpium Historiae. Pemptades VI. Antwerp. 1616. fol.

The first is probably more owing to the very bad manner in which his figures are drawn, which indeed never were faithfully copied. His Nymphaea lutea minor septentrionalium is an ill represented figure, of the Nymphaea minima lately discovered in Germany. The second is to be attributed to carelessness, as he trusted too much to his memory, and hence often imagined he had seen a plant in Britain, which he in fact had met with in other countries.

Charles Clusius or Charles de l'Ecluse, was born at Artois or Atrecht, in the Netherlands, 1526. His parents wished him to become a lawyer, and he went with this design to Loewen. But he soon changed his mind, and, from his great love to botany, soon undertook the most tedious and troublesome journeys through Spain, Portugal, France, Great Britain, the Netherlands, Germany, and Hungary. In his 24th year he already became dropsical, of which however he was cured by the use of cichories recommended to him by the famous physician Rondeletius. In his 39th year in Spain he broke his right arm close above the elbow, falling with his horse, and soon after he had the same accident with his right thigh. In his 55th year in Vienna he sprained his left foot; and eight years afterwards dislocated his hip. This last dislocation was overlooked by his physician, and he had the misfortune to walk for the remainder of his life on crutches. The great pain and difficulty he had thus to suffer when walking, prevented him from taking the necessary exercise, in consequence of which he was affected with a hernia, obstructions in his abdomen, and calculous complaints. Thus miserable and unhealthy, tired of the court of the emperor, where he had resided for fourteen years past, and finding besides the superintendence over the gardens there, too great a burden, he accepted in the year 1593 an invitation as Professor at Leyden, where he died April 6, 1609. Clusius was the greatest genius of his age, and prosecuted the study of botany with an enthusiastic zeal, and a perseverance, which was not equalled by any preceding philosophers, nor by any of his followers. His works* shew us the great botanist, and they will always remain valuable and indispensably necessary. The cuts annexed to them are neat, the figures distinct, and his descriptions masterly. It was a pity that a man of so great merit, should have suffered so much, and even become the first martyr for botany.

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* Matth. de Lobelii, (de l'Obel) Plantarum seu stirpium historia et adversaria. Antwerp. 1576. fol. Begins to be scarce. The number of the figures is 1495. Icones plantarum. Antwerp. 1581. Pars. I. et II. square 4to. The publisher of the first work, Christopher Plantin, has published this without prefixing Lobel's name. It has 1096 plates, with 2173 figures, mostly from Clusius and Dodonaeus.

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* Caroli Clusii rariorum plantarum historia. Tom. I. and II. Antwerp. 1601. fol. He wrote several small treatises, for instance, Plantae pannonicae, hispaniae, historia aromatum, which may be all found in the large work.

§ 372.

THIRD EPOCH.

From CAESALPINUS *till* CASPAR BAUHIN.

Or from 1583 to 1593.

In this epoch Caesalpinus makes the first attempt to bring botany under a systematic form. Many follow his example. The science becomes more universally attended to. Voyages to foreign parts of the globe are undertaken, and the great Bauhin reduces all these new discoveries to a certain order.

Andreas Caesalpinus came from Arezzo in Florence. He was called to Rome; where he died as physician to Clement the Eighth, the 25th of June, 1602. Before him plants had been described without the least order, and nobody thought, by attending to the similarity of different parts, to render the study of botany much more easy. His system, (§ 126), will render him ever memorable. The writings of this botanist* are so rare, that scarcely more than their titles are known now.

Jacob Delechamp, born in the small place Caen in in Normandy, in the year 1513, spent most part of his life at Lyons, and died there 1588, or according to some 1597. He was the first who intended to write a general history of all known plants, but by other occupations he was prevented from continuing it. An accomplished physician at Lyons, of the name of John Molinaeus, completed it at the desire of the bookseller Rovilli *.

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* Andr. Caesalpini de plantis libri XVI. Florent. 1583. 4to. Ejusd. Appendix ad libros de plantis et quaestiones peripateticas. Romae. 1603. 4to.

Joachim Camerarius was born at Nuernberg, the 6th of November, 1534, and died October 11, 1598. He lived with Melanchthon at Wittenberg, when a boy, and afterwards studied medicine at Leipzig. He then travelled over Italy, and graduated 1551 at Rome. He was intimately acquainted with the greatest botanists of his age. By his great zeal for botany, he became noticed by Prince William, Landgrave of Hesse, who was very fond of gardening, and whose garden in Cassel he undertook to arrange. His nephew, Joachim Jungermann, a young but excellent botanist, went, by his desire, to the East, but had the misfortune during his travels to die of an infectious disease. Camerarius wrote several treatises on economical botany, and on the plants of the ancients. His principal work † contains

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* Jacob Dalechampii Historia generalis plantarum, opus posthumum. Leyden 1587. Vol. I. II. fol. 2686 cuts; these contain most of the figures of Cordus, Fuchsius, Clusius, Tragus, Matthiolus, Dodonaeus, and Lobel. More than 400 are two or three times repeated, and the few original ones are exceedingly bad.

† Joachim Camerarii hortus medicus philosophicus. Francf. ad Moen. 1588. 4to. A small treatise of Joannes Thal, a physician

contains 47 figures from Gesner's collection. For he purchased Gesner's whole collection of cuts, which amounted to about 2500. He made great use of them in his edition of Matthiolus, and in another work * still of great value.

Jacob Theodor Tabernaemontanus, a pupil of Tragus, took his name from his native place Bergzabern, a small village in Deuxpont. He was at the beginning apothecary in Kronweissenburg, went afterwards to France, returned as Doctor of Medicine, and at last died as physician to the Elector Palatine, at Heidelberg, 1590. He was generally esteemed for his great skill. His work † was not finished by himself. The second and third volumes were written by another, and are inferior to the first.

Since the Portuguese discovered a passage to the Indies round by Africa, many went there for the sake

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physician in Nordhausen, the Sylvia Hercynia is added to it. This contains an accurate list of all the plants of the Harz. He died at Nordhausen, 1583, by a fall from his horse.

* Joach. Camerarii de plantis epitome. P. Andr. Matthioli. Francf. ad Moen. 1586. 4to. with 1003 fig. Printed along with it is, Iter ad montem Baldum, Fr. Calceolarii. Franciscus Calceolarius, or as his proper name is, Calzolaris, was apothecary at Verona, and published this description of the plants of mount Baldo, in Italian 1566; in Latin 1571 at Venice before Camerarius.

† Jacob Theodor Tabernaemontanus Neuw vollkommen Kraeuterbach, darinnen ueber 3000 Kraeuter mit shoenen kuenstlichen Figuren, &c. &c. Francf. a. M. 1588. Tom. I. fol. The second volume was published 1590 by Dr Nicolai Braun-

sake of trade, as well as soon after the discovery of America by Columbus, love of money induced many to visit that country. Some of them, however, undertook these journeys for the investigation of natural history. Of these deserve to be named, Garzias ab Horto*, Christopher a Costa†, Joseph a Costa‡, Nicolas Monardis, Gonsalvus Ferdinand Oviedo, Franciscus Lopez de Gomara, Franciscus Hernandez‖, and many others.

Leonard Rauwolff, a German, undertook a troublesome journey throughout the Levant. He travelled in the years 1573—1575, through Syria, Arabia, Mesopotamia, Babylon, Assyria, and Armenia. After his return he settled as physician at

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Braun. There are several other editions by Caspar Bauhin, two published at Francfort 1613 and 1625, and two at Basil 1664 and 1687. The Latin edition is in square 4to.; under the title, Icones plantarum sive stirpium tam inquilinarum quam exoticarum. Published twice at Francfort, 1588 and 1590. Many of the figures are taken from others, but they are all very distinct. The Latin editions are scarce.

* Physician to the king of Portugal. Published something on Aromatics in 1563, in 4to. of which we have translations in all languages. Clusius got it printed along with his larger work.

† Surgeon, born of Portuguese parents in Africa, wrote likewise several treatises on Aromatics, to be found in Clusius.

‡ A Jesuit, wrote a work on animals, plants, and fossils. Barcelona. 1578. 4to.

‖ Physician to King Philip the Second of Spain. Nova plantarum et mineralium Mexicanorum historia. Rom. 1651. Very rare, but quite useless.

Augsburg. On account of his religious profession, he was obliged to leave his native place, and died 1596, as physician to the emperor's army. He has published a very complete account of his journey*.

Prosper Alpinus, from Marostica, near Venice, went on account of his love for botany to Egypt. After his return, he practised as physician in Venice, and then in Genoa; he came at last as Professor to Padua, where he died 1617. He was universally regarded as a very able man. Botany is indebted to him for the following writings†.

Joannes Bauhin was born at Lyons, 1541. He was a pupil of Fuchsius, left his native country, and remained for some time in Yverdon, a town in the canton of Bern. He then went to Muempelgard, where he died as physician to the Duke of Wuertemberg, 1613. He travelled through the greatest part of Switzerland and Italy. When a youth, he commenced his great work[*], which he only finished 52 years after.

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* Leonardi Rauwollf, bestallten Medici zu Augsburg, eigentliche Beschreibung der Rais, so er in die Morgenlaender vollbracht, in vier verschiedene Theile abgetheilt. Lauwingen. 1583. 4to. mit 43 Figuren von orientalischen Pflanzen. This edition has cuts, and is rarer than the oldest, which was published at Francfort, 1582. We have French and English translations of it. In the library at Leyden the herbarium which he collected in his travels, consisting of 350 plants, is still preserved.

† Prosperi Alpini de plantis Aegypti liber. Venet. 1591. 4to. Another edition appeared there 1592. There are two other editions, one published at Padua 1639 and 1640, and another at Leyden 1735.

Ejusd. De plantis exoticis libri duo. Venet. 1656. 4to Published by his son Alpinus Alpini.

Fabius Columna or Colonna, an Italian, was born 1567, and was president of the academy at Naples; died 1648. He studied chiefly the older botanists. In his writings[†] he has strictly followed the ancients, without the least systematic arrangement. Of all works on botany his have the best plates. It is only pity that he represents all plants of the same size, whether they are large or small. He made the drawings for the plates himself.

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[*] Johannis Bauhini Historia plantarum. Tom. I. II. III. Genevae. 1661. fol. with 3600 cuts. This work was published after his death, at the expence of Mr De Grafried, by Chabraeus.

[†] Fabii Columnae Φυτοβασάνος sive plantarum aliquot historia, in qua describuntur diversi generis plantae veriores, ac magis facie viribus respondentes antiquorum, Theophrasti, Dioscoridis, Plinii aliorumque, delineationibus ab aliis hucusque non animadversae. Neapel. 1591. with 36 plates. There is a later edition at Florence, published 1744, with 38 plates, which is not by far so scarce as the former.

Ejusd. minus cognitarum nostro coeruleo orientium stirpium εκφρασις. Tom. I. II. Romae. 1606. 4to. Another edition appeared 1616, with 131 plates, which represent 247 plants. This book is very rare. The shop price is about 8s. but I know it has been sold for 4l. The new edition has better plates, and besides a treatise de Purpura, wanting in the first.

§ 373.

§ 373.

FOURTH EPOCH.

From Caspar Bauhin *till* Tournefort.

Or from 1593 to 1694.

Through the persevering exertions of Caspar Bauhin, botany assumes a regular order. He becomes the guide of all other botanists. Discoveries still continue to be made, but fixed generic names, and the means of constituting genera, remain still unknown, till the immortal Tournefort founds a new system, and introduces new generic characters. Centuries elapsed before a system was formed, and when it was formed still another century passed away before it was thought necessary to fix genera, and to take the generic character from the structure of the flower.

Caspar Bauhin, brother to John Bauhin, was born 1560. He travelled like his brother through Italy, where he discovered many plants, which John had overlooked. Bauhin got a Professorship at Basil, and died 1624. Several works* which he has left shew us that he was a great botanist. He succeeded well in his descriptions of plants, and his figures are good. In the work which was to contain all known plants, many are wanting. His nomenclature was, before Tournefort, generally adopted.

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* C. Bauhini Φυτοπίναξ seu enumeratio plantarum ab herbariis descriptarum. Basil. 1598. 4to. with 9 figures. The composition of this work took him 40 years; he has in it enumerated all the species, but considered many varieties as species.

Ejusd. Προδρομος Theatri botanici. Basil. 1620. 4to. An older edition of 1571 contains 140 cuts, which are very distinct.

Ejusd. Theatri botanici liber I. Basil. 1658. fol. with 254 fig.

Basilius Besler, an apothecary at Nuernberg, who died 1561, wrote, at the expence of the bishop of Aichstaedt, John Conrad de Gemmingen, a very elegant work*. Some however assert, that Besler only gave his name, and that the well known Ludwig Jungermann, Prof. at Giessen, was the real author.

Ludwig Jungermann was born Jun. 28, 1572, at Leipzig, died Jun. 26, 1653, at Giessen, as Professor of Physic. He was a very excellent botanist.†

Jacob Cornutius, a physician at Paris, described in a peculiar work, the plants which others had discovered in North America, and some growing in Europe in the gardens of Robinus ‡.

Johannes Loesel, Professor at Koenigsberg in Prussia, was born 1607, and died 1650. His Flora‖, or an enumeration of all the plants which grow wild in Prussia, is the only work he has left us.

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* Basil. Besleri Hortus Eystettensis. Norimb. 1613. Royal fol. with 265 very neat plates, which represent 1080 plants.

† Lud. Jungermann Catalogus plantarum quae circa Altorficum Noricum proveniunt. Published by Maurit. Hoffmann. 1615, 4to.

Ejusd. Catalogus plantarum horti et agri Altorfiani. Altorf. 1646. 12mo.

Ejusd. Cornucopiae florae Giessensis. Giessae. 1623. 4to.

‡ Jacob Cornuti plantarum canadensium aliarumque historia. Parisiis. 1635. 4to. Very rare, but now of little use.

‖ Johann Loeselii plantarum rariorum sponte nascentium in

Joachim Jung was born at Luebeck, Oct. 22, 1587. He was for some time Professor at Helmstaedt; he afterwards went as rector to Hamburgh, and died September 22, 1657. In his writings* he shews a great and extensive knowledge of nature. His remarks on the vegetable kingdom are just, and what he says on Terminology, and on the genera of plants, is done quite in the manner of Linné. Had his works been better known, and had he been situated more favourably for acting more at large, Botany would perhaps have advanced at his time as far as it is now actually advanced.

John Wray, or as he calls himself after 1669, Ray, (Rajus), was born in the village of Black Notely, in Essex, November 29, 1628. During his travels through Great Britain, France, Germany, Sweden, and Italy, he paid great attention to all natural productions. He was a clergyman, and belonged to Trinity college, Cambridge; he resigned,

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in Borussia, catalogus Regiomonti. 1654. 4to. A later edition appeared at Francfort, 1673. 4to.

Ejusd. Flora Prussica edid. Joan. Gottsched. Med. Prof. Regiomonti. 1703. 4to. With beautiful plates.

* Joach. Jungii Doxoscopiae physicae minores, seu, Isagoge physica doxoscopica. Hamburgi. 1662. 4to. In the 2d and 3d part he writes on plants.

Ejusd. Isagoge phytoscopica. Hamburgi. 1679. 4to. A new edition was published in Coburg, 1747, 4to. This last work was published after the author's death, by Joannes Vagetius. The works of Jung are very scarce.

however, his place before going abroad, and at his return lived as a private gentleman. Ray died a member of the Royal Society in London, January 17, 1705. He lived most part of his life in the country. The figure of the flower on which Tournefort founded his system, did not meet with his approbation, and a dispute on that account began between the two philosophers. He is the author of many works on botany, of which we shall only name a few*. He followed Jung in some parts, though not throughout. Ray was one of the most assiduous botanists, and likewise one of the most learned.

Johann. Sigismund Elsholz, born at Berlin, 1623, was physician to the elector Frederic William, and died June 19, 1688. He was the first author who wrote on the plants of the Marc Brandenburg†.

Paul Bocco, called afterwards Sylvius, was born at Palermo, 24th April, 1633, and died December 22, 1704. He was a Cistercian friar. and travelled a great deal through Italy. He has written several small treatises on single plants, but communicated the most remarkable and scarcest in the following works‡.

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* Catalogus plantarum, circa Cantabrigiam nascentium. Cambrigae. 1660. 8vo. This was the first work of Ray; it was published anonymously. Joan. Raji Historia plantarum generalis. Londin. Pars I. 1686. II. 1688. Tom. III. 1703. fol. The most important, and the last work he wrote.

† Joannis Sigismundi Elsholzii Flora marchica. Berol. 1663. 8vo.

‡ Pauli Bocco icones et descriptiones rariorum plantarum Siciliae,

Robert Morison, a Scotchman, was born at Aberdeen, 1620, and died 1683, as Professor of Botany at Oxford, in consequence of a violent contusion of his breast by a waggon. As he had the superintendance of the botanical garden at Oxford, he had ample opportunity to examine the fruits of plants more carefully than any preceding botanists. He has been most esteemed for the accurate division of the umbelliferous flowers, which is printed along with his larger work[*].

Jacob Barrelier was born at Paris, 1634, studied medicine, and just as he intended to graduate became a Dominican friar. He travelled several times through Spain, France, Switzerland, and Italy. During his travels he paid chiefly attention to natural history. He made drawings of plants, insects, and shells, and intended to publish, like Columna, a botanical work, entitled, Hortus mundi, sive Orbis bo-

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Siciliae, Melitae, Galliae, et Italiae. Edidit Morison. Oxoniae. 1674. 4to. With 52 plates, which represent 112 plants.

Ejusd. Museo di Fisica et d'Esperienze. Tom. I. Venet. 1607. 4to.

Ejusd. Museo di piante rare della Sicilia, Maltha, &c. Tom. II. 1647. 4to. These two constitute a work which is extremely rare, but at the same time is inferior in its plates to the first.

[*] Roberti Morisoni historia plantarum. Tom. II. III. Oxon. 1715. fol. with 292 plates, which represent 3600 plants. The first volume of Morison's work was never published. His small treatise on the Umbellatae has therefore been afterwards printed as the first volume, and passes under that title.

tanicus, which was to contain all known plants. While on a journey through Italy he became affected with asthma, which caused his death at Paris, Sept. 17, 1673. The plates have been published since his death*.

Franciscus van Sterrebeck was a clergyman at Antwerp, and died in 1684. Before him little attention had been paid to fungi. He took many from Clusius, added a great number of new ones, and wrote a particular work on them†. But his figures are very bad, as he has entirely neglected the true characteristic marks of fungi, and indeed seems to have given many fictitious representations.

Jacob. Breynius, merchant, and member of several societies, was born at Danzig, 1637, and died of a dysentery, 1697. He corresponded with the first botanists of his age, and got from them many rare plants, which he described in several separate works‡.

Heinrick

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* Jacob Barrelieri Plantae per Hispaniam et Italiam observatae; opus posthumum accurante Antonio de Jussieu. Parisiis. 1714. fol. with 1327 plates, representing 1455 plants. The last plates contain many figures of zoophytes, and of 40 shells. Several of the figures are taken from Clusius and others.

† Francisci Sterrebeck Theatrum fungorum, oft het Tooneel der Campernoellen, &c. Antwerpiae. 1654. 4to. At the same place three other editions appeared of 1675, 1685, and 1712.

‡ Jacobi Breynii Exoticarum et minus cognitarum stirpium. Centuria I. Gedani. 1678. fol. Published at the author's. expence. The 109 plates accompanying it are very neat.

Ejusd.

Heinrich van Rheede tot Drakestein, born 1635, died December 15, 1691. He was governor of the Dutch settlements in the East Indies, and resided chiefly in Malabar. He procured drawings of the principal plants by the first artists, and described them and their use in the following works*.

Christian Menzel was born at Fuerstenwalde in the Marc Brandenburg, June 15, 1622. He is said to have travelled a good deal on purpose to examine the different plants of his native country. Possessed likewise great skill in a variety of foreign languages, and was even well acquainted with the Chinese. Menzel was physician to his Majesty at Berlin, and died November 16, 1701†.

Johann Commelyn, a Dutchman, and Professor of Botany at Amsterdam, has written principally on the plants cultivated in the garden there. His most elegant work‡ was published after his death. Many notes

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Ejusd. Prodromus rariorum plantarum fasciculus I. II. Gedani, 1739. 4to. with 32 plates. This work was published by his son John Philip, a physician at Danzig, who has likewise written several botanical treatises.

* Rheedi Hortus Malabaricus Indicus, cum notis et commentariis Joh. Commelini. Tom. I---XII. 1676, 1693. fol. with 794 very splendid plates. His descriptions are very accurate and faithful. Very scarce.

† Christ. Menzelii Index plantarum multilinguis, seu Pinax botanonimos polyglottos. Berolin. 1682. fol. with 11 plates, which represent 40 plants, not in a very superior style. Scarce.

‡ Joan. Commelini Horti medici Amstelodamensis rariorum tam orientalis quam occidentalis Indiae plantarum descriptio et

notes of consequence were added by him to the Hortus Malabaricus.

Caspar Commelyn, a nephew of the former, and Professor at Amsterdam, was born 1667, and died December 25, 1731. He followed the footsteps of his uncle *.

Rudolph Jacob Camerarius, Professor at Tuebingen, born February 18, 1665, and died 11th September, 1721. Besides some dissertations and small treatises, inserted in the Acta Academiae Natur. Curiosorum, he has not published any great work on botany. Since Pliny philosophers had spoken of the sexes of plants, but nothing certain had been said. Camerarius made the first experiments on the subject.

Paul Hermann, born at Halle in Saxony, July 30, 1640; was for a long time physician at Ceylon; he went afterwards to the Cape of Good Hope, and returned with a full collection of rare plants to Holland, where he became Professor at Leyden, and died January 25, 1695 †.

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eticones. Opus posthumum a Fried. Ruyschio et Fried. Kiggelario. Amstelod. 1697. fol. The plates are beautiful, and the descriptions accurate.

* Casp. Commelini Flora Malabarica. Leyd. 1696. in fol. et 8vo. Ejusdem Praeludia botanica. Amsterdam. 1701 et 1702. 4to. Of the large work of his uncle, he published the second volume 1701. fol.

† Pauli Hermanni Horti academici Lugduno-Batavi catalogus. Leyd. 1687. 8vo.

Augustus Quirinus Rivinus, Professor of Botany at Leipzig, was born December 3, 1652, and died December 30, 1722. One of the first botanists of that century. His system shews how excellent and acute an observer of nature he was*.

Leonhard Plukenet, physician at London, collected with unremitting zeal every thing remarkable in the vegetable kingdom, though he was not in very favourable circumstances. He made a collection of 8000 plants, which for his time was astonishingly large. At the end of his life the queen assisted him, and made him Professor and inspector of the royal gardens at Hampton Court. Plukenet was born 1642, and died 1706. No botanist at that time collected or knew so many plants as he did. His collection is still kept in the British Museum. Though he was in possession of so great a number of plants, yet he was not systematic enough to make any considerable improvements on the science†.

Jacob

Ej. Paradisus Batavus. Leyd. 1698. 4to. Published after his death by Sherard. A very useful work.

Ej. Museum Zeylanicum. Leyd. 1717. 8vo. and another edition in 1726.

* A. G. Rivini introductio generalis in rem herbariam, Lips. 1690. fol. A scarce work, with fine plates.

† Leonhardi Plukenetii Phytographia. Lond. 1691 and 1692. 4to. with 328 plates.

Ejusd. Almagestum botanicum. Lond. 1696. 4to. Almagesti botan. mantissa. Lond. 1700. 4to. with 22 plates.

Ej.

Jacob Petiver, a rich grocer in London, who studied attentively natural history in general, and became member of the Royal Society; died 1718. He has made few original discoveries. In his work* the plates are taken partly from his own collection, partly from the works of others.

Charles Plumier, a Franciscan friar, born at Marseilles, April 20, 1646; made three times a voyage to the West Indies, to describe the productions of the animal and vegetable kingdom. He died at last at the small island Gadis, near the sea port of Cadiz. Plumier made neat drawings of the plants he discovered during his travels, and gave most accurate descriptions. Of his numerous collection, he himself and others after his death, have published but little†.

Ej. Amaltheum botanicum. Lond. 1705. 4to. with 184 plates. All those works are published under the general title, Opera omnia, and constitute a whole. The different plates together represent 3000 plants.

* Jacobi Petiveri opera omnia ad hist. naturalem spectantia. Vol. I. et II. fol. III. 8vo. Lond. 1704. This work comprehends all his writings. The plates represent animals, petrefactions, and plants promiscuously. The third volume is only text, and printed in 8vo.

† Charles Plumier description des plantes de l'Amerique, avec leurs figures. Paris. 1693. fol. with 108 plates. Very scarce.

Caroli Plumieri nova plantarum Americanarum genera. Parisiis. 1703. 4to.

Ejusd. Filices, ou Traité des Fougeres de l'Amerique, en Latin et en Francois. Paris. 1705. with 172 plates, which represent 242 plants. This scarce work contains the figures of all the filices of America, and is on this subject still the best.

The greatest part of his drawings and MSS. was preserved in the national library at Paris.

§ 374.

FIFTH EPOCH.

From TOUTNEFORT *to* VAILLANT.

Or from 1694 to 1717.

Tournefort begins a new era in botany. He fixes the genera more accurately from the structure of the flower, and arranges all known plants. Philosophers continue to arrange gramina and foreign plants according to Tournefort's method, which becomes known all over Europe, till Vaillant shews that not yet all the genera are rightly fixed, and approaches nearer to truth than any preceding naturalist.

Joseph Pitton, called from his native place, Tournefort, was born at Aix in Provence, June 5, 1656; he travelled through France, the Pyrenees, through England, Holland, Spain and Portugal, and went at the king's expence to the Levant. He became afterwards Professor of Botany, and a knight. Unfortunately he lost his life 28th November, 1788, from a contusion on his breast, by a carriage. By his system, and his better discrimination of the genera, he acquired great fame, which could only be obscured by the superior merits of Linné. During his travels in the Levant he was accompanied by a gentleman called Gundelsheimer, who afterwards founded the botanical garden at Berlin. Tournefort's collection of plants is kept in the library at

Paris, and that of Gundelsheimer in the library of the Academy of Sciences at Berlin*.

Sir Hans Sloane, an Irishman, born 1660, studied medicine in France, went to Jamaica, became afterwards physician at London, and President of the Royal Society. Died January 11, 1753. His numerous collection of natural curiosities is deposited in the British Museum. He was a great patron of science in general†.

William Sherard, a great amateur of natural history, who spared no expence with regard to botany. He was a long time British consul at Smyrna, and founded, after his return, at his country seat at Eltham near Oxford, a very fine botanical garden. Except some treatises in the Philosophical Transactions he wrote nothing on botany. Sherard intended to continue the Pinax of C. Bauhin, but died when occupied with it in 1738. He has left a certain sum which is given as a salary to a Professor of Botany in Oxford, who is to publish his great collection of drawings.

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[*] J. Pitton Tournefort relation d'un voyage de Levant. Paris. 1717. 4to. Vol. I. II. We have a German translation, published at Nuernberg. 1776. in 3 vols. 8vo. This work contains many plates.

Ejusd. Institutiones rei herbariae. Tom. I. II. III. Paris. 1719. 4to. with 489 plates. This is the third edition, by the care of Jussieu. I never saw the older ones.

[†] Hans Sloane, Esq.; a voyage to Madeira, Barbadoes, Nevis, St Christophers, Jamaica, with the natural history. London. 1707. fol. A very scarce work, which is even in London sold for 10l.

Olaus Rudbeck, born at Upsal, March 15, 1660; took his degree at Utrecht in 1690, succeeded his father, and died March 23, 1740. His father was the famous Swedish polyhistorian, Olaus Rudbeck, Professor of Botany at Upsala. He intended to describe a number of scarce plants in 12 volumes, with elegant cuts. His work wasentitled, Campi Elysei. But by the great fire, which in 1702 laid almost all Upsal in ashes, his herbarium, and this work were lost. Two copies of the first, and six of the second volume, are still existing, and considered as great curiosities*. The father did not survive this great loss, but died December 12, 1702. The son has, some dissertations excepted, written nothing on botany.

Johan. Jacob Scheuchzer, Professor of Mathematics at Zurich, was born 2d August 1672, and died 1738. He travelled repeatedly through the Alps†, and became on this account very celebrated.

Johann. Scheuchzer, physician at Zurich, has acquired immortal fame in botany, by describing and discriminating the gramina more accurately than had before that time been done, His only fault is, that his descriptions are too prolix*.

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* I saw a copy of this extremely scarce work in the library of Mr Leysser at Halle. The present possessor of the Linnean herbarium, has published a new edition of it, under the following title: Reliquiae Rudbeckianae, sive camporum elyseorum libri primi, qui supersunt, adjectis nominibus Linnaeanis. Lond. 1789. fol.

† J. Jacob Scheuchzeri novem itinera per alpinas regiones facta. Tom. I. IV. Leidae. 1723. 4to. Amongst numerous plates it contains 38 figures of plants.

Maria Sybilla Merian, daughter of the famous Dutch engraver, Math. Merian, born in 1647. Her great love for Entomology induced her to go for some time to Surinam, to see with her own eyes the metamorphoses of the many insects there. After her return, she published a most splendid work† on the metamorphosis of insects, in which several plants likewise were drawn, which Caspar Commelyn described. Some copies are most splendidly coloured by herself. Miss Merian died 1717.

Hermann Boerhaave was born near Leyden, in the village Voorhout in 1668. His father, a clergyman, wished him to take orders, and he was therefore obliged to study divinity. When on a little journey, he met with a merchant, against whom he defended Spinoza's doctrines. That gentleman, in consequence of this, informed against him as a heretic, and follower of Spinoza, and hence he abandoned his former study entirely. Boerhaave afterwards became Professor of Medicine, Chemistry, and Botany, and died September 30, 1738. His fame as physician and natural philosopher, is known all over Europe*.

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* Joh. Scheuchzeri Agrostographiae prodromus, Tiguri. 1708. fol.

Ejusd. Agrostographia sive graminum, juncorum, cyperosum, cyperoidum iisque adfinium historiam. Tiguri. 1719. 4to. The first small work is printed along with this.

* Maria Sybilla Merian Metamorphosis insectorum Surinamensium. Ant. 1705. 1709. fol. with 60 plates, and Dutch and French text.

Engelbert Kaempfer, born in the county of Lippe in 1651. None of the older botanists ever travelled so extensively as he did. For he journeyed ten years in Russia, near the Caspian Sea, in Persia, Arabia, Hindostan, Coromandel, at the banks of the Ganges, in Java, Sumatra, Siam, and Japan, where he remained two years. During these travels he discovered and communicated to the world† many new plants, especially of Japan. His work consists of five numbers, the last of which contains descriptions and figures of Japanese plants. The sixth number, which contained 600 figures of scarce plants, growing at the Ganges, has been entirely lost. He died November 12, 1719.

Louis Fouillée, a Franciscan friar, travelled to Peru and Chili. He published his very accurate journal, containing his observations, and paid particular attention to the officinal plants‡.

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[*] Herrm. Boerhaave Index alter plantarum horti academici Lugduno-Batavini. Pars. I. II. Lugd. 1727. 4to. with 39 plates, which represent mostly plants of the Cape.

[†] Engelb. Kaempferi fasciculi quinque amoenitatum exoticarum. Lemgo. 1712. 4to. with many plates, which however are not very neat.

[‡] Louis Feuillée Journal des observations physiques, mathematiques et botaniques, faites par ordre du Roi, sur les cotés orientales de l'Amerique meridionale. Paris. Tom. I. II. 1714. Tom. III. IV. 1725. 4to We have an extract of the botanical part in German.

§ 375.

§ 375.

SIXTH EPOCH.

From VAILLANT *till* LINNE.

Or from 1717 to 1735.

Vaillant's perspicacity discovers the faults in Tournefort's system, and in his genera. He fixes new genera, endeavours to bring the smallest plants, as mosses and fungi, under a csrtain classification, and first clearly points out the sexes of plants. What Vaillant was unable to do, to arrange the mosses accurately and justly, has been ably executed by Dillenius and Micheli. Linné's great genius gives the whole science a more favourable appearance, and bòtany now becomes, what it should have been long before, a structure resting upon a firm foundation.

Sebastian Vaillant was born 26th May, 1669, at Vigny in France. He studied surgery, but his great love for botany induced him to study this science exclusively. Tournefort, whose pupil he was, did every thing in his power to complete the education of his very promising pupil. He became demonstrator of botany at Paris. From too great a zeal for botanical knowledge, he travelled on foot through all the neighbourhood of Paris, and thus became consumptive, which put (May 21, 1722), an end to his active life.

The smaller plants became the chief object of his attention. He recognised in the pollen of the Parietaria the semen masculinum, and did not, with

Tournefort, consider it merely as an execrementitious matter of the flower*.

Heinrich Bernhard Ruppius, a student at Giessen, was born to be a botanist. He travelled through the greatest part of Germany on foot, content with poor sparing diet, often sleeping in the open air. His knowledge of plants was far more than superficial, and he often even distinguishes plants by their stamens, and enumerates many new genera†.

Johann. Jacob Dillenius, born in Hessia, 1684; became Professor in his native city, but was soon called to Oxford, as Professor, where he died in 1747. Like Vaillant he could instantly discriminate the smallest plants. Dillenius has characterised the mosses, and his descriptions stand as a model of perspicuity. He could himself draw and engrave‡.

Johann. Christian Buxbaum was born at Merseburg, in Saxony, in 1694, and studied at Leipzig, Jena and

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* Sebastiani Vaillant botanicon Parisiense, ou dénombrement par ordre alphabetique des plantes, qui se trouvent dans les environs de Paris. Leidae. 1727. fol. with very neat plates, published by Boerhaave, after the author's death. Several smaller treatises are to be found in the Memoires de l'Academie de Paris.

† Henrici Bernhardi Ruppii Flora Jenensis. Francf. and Lips. 1788. 8vo. Haller published a new edition at Jena, in 1745.

‡ Joh. Jacob Dillenii Catalogus plantarum sponte circa Giessam nascentium. Giessae. 1719. 8vo.

Ejusdem.

Wittenberg. The great Friedrich Hoffmann in Halle, recommended him to Count Alexander Romanzof, who went as ambassador to Constantinople. He visited many parts of Greece, and returned to Petersburg. This he left in a bad state of health, and died July 17, 1730, at Wermsdorf near Merseburg*.

Peter Antony Micheli, a poor gardener, was born 1679.; he was in his last years inspector of the botanical garden at Florence, and died January 1, 1736. None of his predecessors dissected flowers so minutely. He first observed the true flower of mosses, though he did not distinguish accurately the different parts of it. Micheli was likewise the first who discovered the fruit of fungi†.

Ejusdem Hortus Elthamensis. Londin. 1732. fol. with 324 good plates, which represent 417 plants. This has again been published without text, under the title, Horti Elthamensis icones et nomina. Leyden. 1774. fol. with Linnean names.

Ej. Historia Muscorum. Oxon. 1741. 4to. with 85 plates, which represent about 600 mosses; an incomparable work. In this department of botany nothing almost had been done, and in his work it has been first fully treated of. It is very scarce, for there were scarcely 250 copies printed. A separate reprint of the plates appeared in London. 1763.

[*] J. C. Buxbaumi Plantarum minus cognitarum Cent V. Petropol. 1728. 4to. The last Centuries were published by Gmelin, the sixth never appeared. He gives many figures of African plants which he found in the East.

[†] P. A. Michelii nova plantarum genera. Florent. 1729. 4to. with 108 very neat plates. It is a pity that the second part of this excellent work has been lost.

§ 376.

SEVENTH EPOCH.

From LINNÉ *till* HEDWIG.

Or from 1735 to 1782.

Linné demonstrates the presence of sexes in plants, shews the only right way to constitute genera, invents a new system, and arranges accordingly all known plants. His pupils disperse all over the globe, and discover new plants. His system becomes known throughout all Europe, and every where finds adherents. Hedwig at last discovers the flowers of mosses.

Carolus de Linné was born in the Swedish village Rooshoolt, in the province Smaland, May 23, 1707. His father, a clergyman, wanted him to study divinity; the gay youth, however, preferred the open air, and the gathering of plants. This made his father destine him for a shoemaker. Thus, had not the provincial physician at Wexioe, Rothmann, interested himself for him, and persuaded his father to let him study medicine, Linné' great genius would have been for ever suppressed. Linné spent his academical life under a great many hardships, and in great poverty. Celsus, Professor of Divinity at Upsal, and Rudbeck, at last, began to favour him. He travelled at the expence of the academy through Lapland, got after his return, acquainted with the daughter of Dr Moraeus, afterwards his wife, who presented him with money to go to Holland to take his degree. Boerhaave recommended him to Dr Cliffort, of whose garden and herbarium he had full use, and who sent him for a short time to England. After Rudbeck's death he became Professor of Botany at Upsal. The king made him baronet, and at last archiater, and knight of the order of the Polar star. He died January 8, 1778. Linne's works are too numerous for us to mention them all, it will suffice to notice the last and best editions of his principal works *. His real merit in botany consists in having constituted the genera on better principles, given proper generic and trivial names, introduced a better terminology, described the species more accurately, and invented a new comprehensive system founded upon the sexes of plants.

Albrecht von Haller was born 1708. He studied at Leyden under the direction of the great Boerhaave, became Professor of Anatomy and Botany at Goettingen, left that celebrated academy, and went to Bern, where he became President of the great senate, and died 1777. Haller was one of the greatest geniusses of our present age, great as anatomist, physiologist, botanist, physician, poet, as politician, and †man of letters.

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* Carl a Linné. Systema plantarum curante D. Joh. Jac. Reichard. Francf. a M. Tom. I. II. III. IV. 1779 and 1780. 8vo.

Ejusd. Genera plantarum curante J. Christ. Dan. Schreber. Francof. a M. Tom. I. 1789. II. 1790. 8vo.

Ejusd. Species plantarum, curante D. Carl Ludwig Willdenow. Tom. I. II. III. Leipz. 1801. 8vo.

† Albrrechti ab Haller historia stirpium indigenarum Helvetiae. Bernae. 1768. Tom. I. II. III. fol. with 48 plates.

John Gottlieb Gleditsch, was born June 5, 1714, at Leipzig. He studied there, and travelled through several parts of Saxony. From Berlin, where he resided for some time to attend the anatomical lectures, he went to the estate of Baron von Ziethen of Trebnitz, where he founded a botanical garden. When Frederick the Great re-established the Academy of Sciences, he was called to Berlin. There he was honoured with the title of Aulic Counsellor, and died after a very active life, Oct. 5, 1786. His restless activity, soft, mild temper, and constant good humour, made him, even when a very old man, the favourite of that city. Of his writings I shall only mention those which have made him particularly known*.

Johann. Burmann, Professor of Botany at Amsterdam, in possession of the scarcest collections of African and Asiatic plants, made many of his treasures known to us†. He never followed, however, the Linnean method.

Johann. Friederich Gronovius, doctor and chief magistrate at Leyden, and a great friend of Linné, published the plants collected by Rauwolf and Clayton,

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* Joh. Gottl. Gleditschii Methodus fungorum. Berol. 1753. 8vo.

Ejusd. Systema plantarum a staminum situ. Berol. 1764. 8vo.

† Joh. Burmanni Thesaurus Zeylanicus. Amstel. 1737. 4to. with 110 plates, which represent 155 plants.

Ejusd.

ton, and described them according to Linne's method. Died in 1783*.

George Eberhard Rumphius was born at Hanau. He went as physician to the East Indies, where he became chief magistrate and president of the mercantile association of Amboyna, and collected carefully all the productions of India, especially plants, but was, at an old age, unfortunate enough to lose his sight entirely, so as to judge of every thing by the touch only. Died 1706†.

Johann Gottlieb Gmelin was born in 1710, at Tuebingen; went at the advice of some friends in 1727 to Petersburg, where he became a member of the academy there. He travelled through Siberia, and died 1755. From the MSS. left by the unfortunate Steller, Gmelin published a work, the two last volumes of which appeared after his death ‡.

John Hill, an Englishman, had an idea of getting all the plants mentioned by Linné engraved. This very

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Ejusd. rariorum Africanarum plantarum Decas I. IX. Amstel. 1738, 1739. 4to. with 180 plates, containing 215 figures of the scarcest plants.

* Joh. Fried. Gronovii flora virginica. Pars I. et II. Lugdun. 1743. 8vo.

Ejusd. Flora orientalis. Lugdun. 1755. 8vo.

† Georgii Everhardi Rumphii Herbarium Amboinense. Tom. I.—VI. cum auctuario. Amstel. 1750---1755. fol. with 196 plates.

‡ Joh. Gottl. Gmelin Flora Sibirica. Tom. I.—IV. Petropol. 1748, 1769. 4to. with 299 plates. The two last volumes were published by his nephew Sam. Gottl. Gmelin, the fifth, however, which contains Cryptogamiæ, is not yet printed.

large work however is useless, on account of the very bad figures, and indeed of too enormous a price. Most of the drawings are not taken from nature but from descriptions. It is not therefore surprising that they often do not bear the slightest resemblance to the natural flowers *.

Charles Allione, Professor of Botany at Turin; an old botanist, still alive, who paid great attention to the plants of his native country †.

George Christian Oeder was called to Copenhagen in 1752 where he became Professor of Botany. In 1770 the institution to which he belonged as Professor became disannulled. He became afterwards bailiff at Trondheim and finally went as provincial judge to Oldenburgh, where he remained till the end of his life, which happened January 28, 1791. A few years before he was ennobled Besides many other botannical treatises he has particular merit in publishing the Flora Danica, which the King of Denmark still patronizes ‡.

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* John Hill's Vegetable System. Vol. I.—XXVI. London, 1759---1775. fol. with 1521 plates, which represent 5624 plants, but no trees, gramina, or cryptogamic plants.

† Caroli Allione Flora Pedemontana. Tom. I. II. III. August. Taurin. 1785 fol. with 92 plates.

‡ Flora Danica, Hafn. fol. Oeder began this splendidly coloured work in 1766. He published three volumes before the year 1770. A volume consists of three numbers, each containing 60 plates. After his death it was continued by the famous zoologist Otto Frederic Mueller, who died in 1787. The continuation was afterwards intrusted to Professor Vahl, and at present 20 numbers are published; consequently 1200 plates, with the figures of Danish plants.

Nicolaus Laurentius Burmann, who lately died, Professor of Botany at Amsterdam, was son of John Burmann. He used the great collection which his father left, entirely for the benefit of the science, and published part of it, according to the arrangement of Linné, his great master *.

John Anton Scopoli, was born at Fleimsthal in Tyrol, 1722. Almost without any instruction he became by his own diligence a very great man, and an acute observer of nature. He was first physician at Idria, went afterwards to Schemnitz in Hungary as Professor, and lastly to Pavia, where he died May 3, 1788. By too frequent a use of the microscope, a year before his death he lost his sight. It is singular, that a man whose whole life was a series, as it were, of misfortunes, should have done so much †.

Johann Christian Daniel von Schreber, born 1739, a pupil of Linné, President of the Imperial academy, and Professor at Erlangen. One of the first botanists, whose great merits are universally acknowledged. His writings bear the mark of mature reflection and just observation ‡.

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* N. L. Burmanni Flora Indica. Lugd. 1768. 4to. with 67 plates, which represent 176 very scarce plants.

† Joh. Ant. Scopoli Flora Carniolica. Tom. I. II. Vindb. 1772. 8vo. with 65 plates.

Ejusd. Deliciae Floræ et Faunæ Insubricæ. Tom. I. II. et III. Ticini 1786. fol. with 75 plates. An elegant work, of which only a few copies were printed.

‡ J. C. D. Schreberi Spicilegium Floræ Lipsiensis. Lipsiæ 1771. 8vo.

Nicolaus Joseph von Jacquin was born in the Netherlands. He made a voyage, at the expence of the Emperor Francis I. to the West Indies, became afterwards Professor at Schemnitz, whence he went in the same quality to Vienna. This botanist, who is still living, has done much for the progress of the science, and we have in fact from him most of the new discoveries in botany. His works are unfortunately too expensive ‡.

Jacob Christian Schaeffer, a clergyman at Ratisbon, should not be passed unmentioned, as he was the first who published coloured prints of fungi. For German botanists his work is classical, particularly with respect to the larger species *.

Charles Linné, the son, was born at Upsal, January 20, 1741. In his nineteenth year he became demonstrator

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Ejusd. Beschreibung der Graeser (Description of the Gramina.) Vol. I. and II. Edit. 1st—3d. Leipzig, 1769—80. fol. with 40 coloured plates. It is a pity that the learned author has not continued this work.

‡ N. Jos. Jacquini Flora austriaca. Vol. I.—V. Vindobon. 1773—78. fol. with 500 coloured plates. Very scarce.

Ejusd. Miscellanea austriaca. Vol. I. II. Vindob. 1778—1781. 4to. with 44 coloured plates.

Ejusd. Collectanea ad Botanicam, Chimiam et Historiam Naturalem. Vol. I.—V. Vindob. 1786—96. 4to. with 106 coloured plates.

Ejusd. Icones plantarum rariorum. Vol. I. III. Vindob 1781---1793. fol. with 648 coloured plates.

Ejusd. Plantarum rariorum horti Cesaræi Schoenbrunnensis descriptiones et icones. Vol. I. II. Vindob. 1797. fol. with 250 coloured plates.

* Dr Jac. Christian Schaeffer fungorum qui in Bavaria et Palitinatu

monstrator of botany, got, after his father died, the botanical professorship, and died November 1, 1783. He had great botanical knowledge, but did not equal his father †.

Peter Jonas Bergius, Professor of Natural History at Stockholm, celebrated for his investigations of the Cape and of Surinam ‡.

Samuel Gottlieb Gmelin, Professor of Botany at Petersburg, a nephew of the former, born in 1753. He has given very accurate descriptions of sea plants *.

Samuel George Gmelin, travelled through several parts of Russia for the purposes of natural history. He died in prison at the Cham of the Chaitakkes, 1774, shortly before he was to have been ransomed ||.

Peter Simon Pallas, born at Berlin, went to Petersburg, and travelled at the expence of her Imperial Majesty Catherine II. through the Asiatic provinces of Russia. The result of these travels this great philosopher has communicated to the world, likewise

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Palatinatu circa Ratisbonam nascuntur icones, nativis coloribus expressae. Vol. I.—IV. Ratisb. 1762. 4to. with 330 coloured plates. The fourth volume contains the systematic description of them all.

† Carl a Linné Supplementum plantarum. Brunsw. 1781. 8vo.

‡ P. Jon. Bergii Plantæ capenses. Holm. 1767. 8vo. with 5 plates.

* Sam. Gottl. Gmelin Historia fucorum. Petrop. 1768. 4to. with 33 copper-plates.

|| Samuel George Gmelin Reisen durch Russland, (Travels through Russia), Vol. I.—III. Petersburg, 1770—1789. 4to. with 18 plates.

at the expence of the Empress. It is to be wished that the author may continue this elegant work ‡.

Johann Gerard Koenig from Curland, was an apothecary, and afterwards studied under Linné. He went afterwards to Copenhagen, from whence he visited Iceland in 1765. After his return he accompanied the mission, as physician to Tranquebar, in the East Indies in 1768. During this voyage he collected at the Cape of Good Hope many unknown plants, and sent them to his instructor Linné. His zeal for botany had no bounds, but his pecuniary circumstances were not in his favour. He entered as natural historian the service of the Nabob of Arcot, from whom he got a better salary, which he spent entirely in his various investigations. But still, though in better circumstances, finding that his income would not suffice for the execution of his extensive plans, he petitioned the Directory of Madras for an additional salary, which was granted. He died June 26, 1785, without having all his discoveries published. Single treatises of his are inserted in different periodical publications, and in the third number of Retzii Observationes Botanicæ, we have his masterly descriptions of all the Monandriæ of the East Indies; and in the sixth number an enumeration and description of all the Indian species of Epidendron.

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‡ P. S. Pallasii Flora Rossica. Tom. I. Pars. 1. 2. Petro. fol. 1784. 1788. fol. with 100 coloured plates. The text has been separately printed in 8vo.

Christian Friis Rottböll, who died in 1797, Professor of Botany at Copenhagen, has described a great many foreign plants. His chief merit is the description of several exotic species of gramina *.

Fusée Aublet, a Frenchman, was an apothecary, and went with a great deal of botanical knowledge to Guyana in America. After having made there a great many discoveries in botany, he went to the Isle of France or Mauritius, and returned to France, where he died some years ago †.

Johann Reinhold Forster, late Professor of Halle, and his son George Forster, private counsellor and librarian at Maynz, made a voyage round the world with Captain Cook. Both philosophers have communicated to the world an account of the plants which they discovered during their voyage ‡.

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* Christiani Friis Rottböllii Descriptiones et icones Plantarum. Hafniae 1773. fol. with 21 plates. An improved edition appeared in 1786.

† Fusée Aublet Histoire des Plantes de la Gujane Francoise. Tom. I.—IV. Lond. et Paris. 1775. 4to. with 392 plates.

‡ Joh. Reinh. Forsteri Characteres Generum Plantarum, quas in itinere ad insulas maris australis collegit. Lond. 1776. 4to. with 75 plates.

Georg. Forsteri Plantae esculentae insularum oceani australis. Halae, 1786. 8vo.

Ejusd. Florulae insularnm australium prodromus. Goettingae. 1786. 8vo.

Conrad Moench, Professor at Marburg, has favoured us with many excellent botanical observations *.

Bulliard died in 1796 as demonstrator of botany at Paris; he wrote several treatises on the plants which grow wild in the neighbourhood of Paris; and in his larger work described the rarest fungi †.

Chevalier Lamark, once an officer in the army, afterwards member of the national institute at Paris, has shewn himself, by the publication of a great botanical work ‡, a very expert botanist.

Andreas Johann Retzius, still living, and Professor of Botany at Lund in Sweden, was born October 3, 1742. We are indebted to him for several new discovered plants by travellers, and for many important observations ||.

Charles Peter Thunberg, knight of the order of Vasa, Professor at Upsal, is the son of a country

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* C. Moench Enumeratio Plantarum indigenarum Hessiae praesertim inferioris. Pars Prior. Casselis. 1777. 8vo. The second part has never been published.

Ejusd. Verzeichniss auslaendischer Bäume und Straeucher des Lustschlosses Weissenstein bey Cassel. (Catalogue of foreign trees and shrubs in the palace of Weissenstein near Cassel). Frankf. and Leipz. 1785. 8vo. with 8 uncoloured plates.

Ejusd. Methodus Plantas horti Botanici et agri Marburgensis a staminum situ describendi. Marburgi. 1794. 8vo.

† Bulliard, Herbier de la France, with many coloured plates.

‡ Chevalier de Lamark Encyclopedie methodique. Tom. I. II. III. Paris, 1783, 1784. 4to. with numerous plates.

|| And. Joh. Retzii Observationes Botanicae. Fasc. I. VI. Lips. 1779.—1791. fol. with 19 plates.

curate. He visited Holland and France, and went, assisted by some friends in Holland, to the Cape of Good Hope, Ceylon, Java, and Japan. Thunberg has written a great deal on several botanical subjects, and we have sill more to expect from him. His Flora Japonica is a model which deserves general imitation †.

Sir Joseph Banks, Bart. and President of the Royal Society in London, in company with his friend Dr Solander, made the first voyage with Captain Cook round the world. Sir Joseph is in possession of the largest herbarium and of the scarcest natural productions in general. We expect from him an elegant work on all the plants of the southern part of India. This great man is the patron of natural history in general ‡.

We must content ourselves with mentioning the names only of some other celebrated botanists who would deserve a more particular account, were our limits not so narrow. They are, Miller, Ludwig, Ammann, Van Royen, Seguier, Sauvages, Gessner, Steller, Gerber, Georgi, Guettard, Messerschmidt, Kalm, Hasselquist, Osbeck, Loeffling, Vandelli, Forskoel, Adanson, Schmiedel, Hudson, Lightfoot, Gouan, Necker, Weigel, Murray, Commerson, Sparrmann, Wulffen, Leers, Cranz, Medicus, Pollich, Weber, Asso, and many others.

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† C. P. Thunberg Flora Japonica. Lipsiae. 1784. 8vo. with 39 plates.

Ejusd. Icones Plantarum Japonicarum. Upsaliae, 1794. fol. Only 10 plates have appeared uncoloured.

Ejusd. Prodromus Plantarum capensium pars prior. Upsaliae, 1794. 8vo. with three plates. This first part contains the short characters of all the plants which he discovered at the Cape of Good Hope, up to the tenth class of Linné.—The complete Flora Capensis is to be published soon, which will be a gratification to many, who wait for it with anxiety.

‡ Josephi Banks Reliquiae Houstonianae. Londini, 1781. 4to. with 26 plates.

Ejusd.

§ 377.

EIGHTH EPOCH.

From HEDWIG *till our present time.*

Or from 1782 to 1805.

Though Linné arranged all the productions of nature, and in the vegetable kingdom observed decidedly the sexes of plants, yet he had not succeeded in discovering the sex and the sexual organs in the cryptogamiæ. Hedwig alone is so fortunate. To him we are indebted for a better knowledge of the cryptogamiæ and an entire reform in this important branch of botany. Many men of merit undertake tedious and dangerous journeys through the most distant regions of our globe, and by them we expect to get acquainted with scarce and unknown natural productions. This whole century may, with regard to

Ejusd. Icones selectae Plantarum, quas in Japonia collegit et delineavit Engelbertus Kaempfer ex Archetypis in Museo Britannico asservatis. Lond. 1791. fol. Contains 59 uncoloured plates, left by Kaempfer, with systematic descriptions.

to natural history, justly be called the century of discovery. It must however be admitted, that, did philosophers really wish to make their writings more generally useful, they would make their works less expensive, and not give us repeatedly copied plates, which only render the study less attainable. Besides, we are so unfortunate since Linné's death to get new plants under different names, and to see new names given to plants already known. Should this anarchy become prevalent in botany, we must expect to see again the old times where each author gave to his plant the name he fancied to be the best.

Johann Hedwig, Professor of Botany at Leipzig, born at Cronstaedt in Transylvania, Oct. 8, 1736, studied medicine at Presburg in Hungary, and died Feb. 7, 1799, at the age of 69 years. He discovered by means of an extremely high magnifying microscope, that those parts in mosses, which Linné took for female flowers, were male flowers, and that those which were thought to be the male flowers were seed capsules only. His discoveries relate likewise to the filices, algæ, and fungi *.

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* Johannis Hedwigii Fundamentum Historiæ Naturalis muscorum frondosorum. Pars I. II. Lipsiæ, 1782, with 20 plates.

Ejusd. Theoria generationis et fructificationis plantarum cryptogamicarum. Petropol. 1784. 4to. with 37 coloured plates. In 1798 a new, corrected, and much enlarged edition of this work was published.

Ejusd. Descriptio et Adumbratio muscorum frondosorum. Tom. I.—IV. Lips. 1787—1797, with 160 neatly coloured plates. Not continued.

Jonas Dryander, a Swede by birth, who lives with Sir Joseph Banks; a very profound botanist, who by some single treatises has gained much reputation. The description of Sir Joseph Banks's library, which he has published, shews his great knowledge *.

Charles Louis l'Heritier de Brutelle, formerly member of the National Institute at Paris, has made himself known by the descriptions of several new plants. He has especially described many Peruvian plants, discovered by Dombey during his travels. His works are rather of too large a size, and on account of the many elegant plates very expensive†.

George

A posthumous work on mosses, containing their general history, has been since published by Dr Hedwig's favourite pupil, Dr F. Schwaegrichen of Leipzig. It is Hedwig's Species Muscorum, with his own drawings; and his son and successor in the botanical chair has published some others. T.

* Catalogus Bibliothecæ Historico-Naturalis Josephi Banks, auctore Jona Dryander. Tom. III. 1797—98. The third volume contains the botanical works, which the author has arranged in a particular order. But what renders this work indispensibly necessary for every botanist is this, that all the known and new plants which botanists have described in periodical works, or in the publications of academies and learned societies, are enumerated there, according to Linné's system.

† C. L. l'Heritier, Cornus. Parisiis. 1788. fol. with plates.

Ejusd. Sertum Anglicum. Paris. 1788. fol. with many plates. Not yet finished.

Ejusd. Stirpes novae. Fasc. I.---VI. 1784---1789. with 84 neat uncoloured plates. Continued.

Ejusd. Geraniologia seu Erodii, Pelargonii, Geranii, Monsoniae et Grieli historia, iconibus illustrata. Parisiis. 1787. fol. Only 44 plates without text have hitherto appeared. He

has

George Franz. Hoffmann, born in Bavaria, was Professor at Erlangen, but went 1792 to Goettingen, as Professor of Botany. He has, by descriptions and drawings, pretty well explained some extensive not yet properly fixed genera*.

Anton. Joseph Cavanilles, born at Valencia; an abbé who lived with the Spanish ambassador at Paris, but now resides at Madrid, and has several times travelled through Spain. He has deserved well of botanists, by having described and accurately discriminated the Monodelphiae. He intends now, in a particular work, to describe the plants in the botanical garden at Madrid, and some new plants of Spain†.

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has promised an accurate description of the genus Solanum, and to publish Dombey's flora Peruviana.

* Georgii Francisci Hoffmanni Enumeratio Lichenum. Fasc. I---IV. Erlangae. 1784. 4to. with many plates. It is a pity it is not continued.

Ejusd. Historia Salicum. Tom. I. Lips. 1785. fol. with 24 plates. This work is not finished, though it is much to be wished that the author may continue it.

Ejusd. Plantae Lichenosae. Tom. I---III. Lipsiae. 1790---1796. fol. Each volume has 24 elegantly coloured plates, and it is to be continued. This work is very useful to the botanist, only the generic names are not very accurate.

† Ant. Joseph Cavanilles Monadelphiae Classis Dissertationes decem. Matriti. 1790. 4to. with 296 elegant plates.

Ejusd. Icones plantarum. Vol. I---III. Matriti. 1791---1794. fol. Each volume contains 100 uncoloured plates, neatly engraved; with the 4th volume the whole will be concluded. It contains a great treasure of New Mexican and Spanish plants.

Johann. Jacob Roemer, and Paulus Usteri, two physicians at Zurich, have published journals of botany, in which many discoveries are collected, and by which botany has gained many admirers and friends. In the beginning they published this journal both together*, afterwards each a separate one.

Joseph Gaertnèr, physician at Kalve near Stuttgard, died in 1791. His particular merits consist in an accurate inquiry into the nature of seeds. His work is most useful, as it fills up a large empty space in the physiology of these organs†.

Olof Swartz, now Professor at Stockholm, resided from 1783 till 1787 in the West Indies, where, though Browne, Sloane, Plumier, Aublet, Jacquin, and some others had before him visited these countries, he still discovered many plants entirely unknown. He has made these discoveries known, and thus has contributed to the better knowledge of plants. The Cryptogamiae especially, have gained much by his discoveries*.

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* Magazinder Botanik, herausgegeben vong J. J. Roemer und P. Usteri. I.---IV. Band Zuerch. 1787---1790. 8vo. (Botanical Magazine, published by J. J. Roemer and P. Usteri).

Dr. Usteri afterwards published, Annalen der Botanik. (Annals of Botany) 1---2. Vol. Zuerch. 1792, 1793. 8vo.

Neue Annalen der Botanik (New Annals) No 1---16. Zuerch. 1794---1797, 8vo. This last journal is still continued, and contains many interesting articles.

Dr Roemer has begun a new journal, remarkable for its elegance, aud the good choice of communications, viz.

Archiv für die Botanik, 1--3 Stück, (Magazine for Botany, No. 1---3), Leipzig. 1796---1798. 4to.

† Josephi Gaertneri de fructibus et seminibus plantarum, vol. I. II. Stuttgard, 1788---1791. 4to. with 180 neat plates.

James Edward Smith, physician at Norwich, and President of the London Linnean Society, was fortunate enough to purchase the whole Linnean herbarium. It could not have come into better hands, for from it he has characterised more accurately several scarce and but imperfectly known plants, and by publishing descriptions of many new plants, especially of New Holland, and fixing the genera in the filices on more solid foundations, he has gained everlasting fame. His writings are of great value to the botanist†.

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* Olof Swartz nova genera et species plantarum seu Prodromus descriptionum vegetabilium maximam partem incognitorum, quae sub itinere in Indiam occidentalem digessit. Holmiae. 1788. 8vo.

Ejusd. Observationes botanicae, Erlangae. 1791. with 11 plates.

It appears but just to observe, that Mr Swartz saw the greatest part of the plants described in his Prodromus first in Sir Joseph Banks's collection. They were, at least 12 years before Mr Swartz wrote this work, collected and sent to Sir Joseph by Dr Wright, now in Edinburgh. T.

Ejusd. Icones plantarum incognitarum quas, in India occidentali detexit atque delineavit. Fasc. I. Erlang. 1794. Only six neatly coloured plates have been published.

Ejusd. Flora Indiae occidentalis aucta atque illustrata, sive descriptiones plantarum in prodromo recensitarum. Tom. I. II. Erlangae. 1797, 1798. Continued. The first volume contains 15 neat plates representing the anatomy of the new genera.

† Jacobi Edward Smith Plantarum icones hactenus ineditae.

William Aiton, inspeector of the royal botanic garden at Kew near London; died 1794. An excellent observer, who has presented us with an elegant description of the plants in the garden at Kew*.

Johann. de Loureiro, a Portuguese, went as missionary to Cochinchina, but as he could not, without medicine, succeed in his plans, he studied the productions of the vegetable kingdom. After a residence there of about 30 years, he went with a Portuguese ship to Mozambique, and finally returned to Portugal. We have from him a valuable work on the plants which he met with during his journey†.

Jacob Julian la Billardiere, physician at Paris, intended, after he had travelled through the mountains of Dauphiny and Savoy, to undertake a botanical journey, under the patronage of the minister

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editae. Londin. Fasc. I. II. III. 1789---1791. fol. with 75 good plates.

Ejusd. Icones pictae plantarum rariorum. Fasc. I---III. Lond. 1790---91---93. An expensive work. Each fascicle has 6 well coloured plates.

Ejusd. Specimen of the Botany of New Holland, vol. I. Fasc. I. IV. Lond. 1793. 4to. 1794. Each fascicle contains four neatly coloured plates.

* Hortus Kewensis, or a catalogue of the plants cultivated in the royal botanic garden at Kew, by William Aiton. Vol. I. II. III. London. 1789. 8vo. with a few very good plates. A new edition of this useful work is expected.

† Joannis de Loureiro Flora Cochinchinensis. Tom. I. & II. Ullissipone. 1790. I have myself published an edition of it in 8vo. in 1798, by Spener, with notes.

de Vergennes, through Asia Minor as far as the Caspian Sea. He left Marseilles, November 19, 1786, and arrived in Syria, in February, 1787. The plague, however, which then raged in those countries which he intended to visit, obliged him to alter his plan, and to confine himself to Syria only. Fifty or sixty new discovered plants he has begun in a masterly manner to describe in a particular work *.

Martin Vahl, Professor at Copenhagen, has travelled through the greatest part of Europe, and North Africa. The Arabic plants of Forskool, as well as those of the West Indies, which his friends Rohr, Ryan, and West collected, many East Indian plants, and a great many discovered by himself, are communicated to us in his writings†. Vahl has shewn himself one of the greatest botanists of the age.

Frederic Stephan, Professor and Counsellor at Moscow, born at Leipzig, has published a Flora of Moscow, and he has promised an elegant work on new Asiatic plants‡.

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* J. J. Billardière, M. D. Icones plantarum rariorum Syriae descriptionibus et observationibus illustratae. Parisiis. Decas I. 1791, Decas II. 1791, 4to. The plates and descriptions are excellent. It isa pity that no more has been published.

† Martini Vahl Symbolae plantarum. Pars I.---III. Hafniae, 1790---1794. fol. Each volume has 25 plates; all three, therefore, 75.

Ejusd. Eclogae botanicae. Fascicul. I. Hafn. 1796. fol. with 10 plates.

‡ F. Stephan enumeratio stirpium agri Mosquensis. Mosquae. 1792. 8vo.

Ejusd. Icones plantarum Mosquensium. Decas I. Mosquae, 1795. fol.

Frederick Alexander von Humboldt, chief counsellor of mines in Prussia, born at Berlin, has much contributed to the knowledge of subterraneous plants *. Physiology, especially the physiology of plants, owes to him a great many important discoveries and explanations. His unwearied zeal for science makes us hope for a great many excellent communications in consequence of his extensive travels.

Christian Conrad Sprengel, once rector at Spandau, now a private gentleman at Berlin, discovered, after many tedious examinations and observations, the true manner in which nature has provided for the fecundation of plants. He has written a particular work on the subject, full of important observations †.

Heinrich Adolph Schrader, Doctor of Medicine at Goettingen, has besides dry cryptogamic plants, of which he published collections, written several works, which contain many very excellent observations ‡.

William

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* Florae Fribergensis specimen, edidit Fried. Alex. ab Humboldt. Berolini. 1793. 4to. with four neat, uncoloured plates, representing 19 subterraneous plants.

† Das entdeckte Geheimniss der Natur im Bau und in der Befruchtung der Blumen, von C. C. Sprengel. (The secrets of nature in the structure and fecundation of flowers, by C. C. Sprengel). Berlin. 1793. 4to. with 14 plates, which contain a great number of neat figures crowded together.

‡ Spicilegium Florae Germanicae Auctore H. A. Schrader. Hannov. 1794. in 8vo. with 4 plates, which represent various cryptogamic plants, and the seeds of some species of Galium.

Ejusd.

William Roxburgh, an Englishman by birth, now physician at Samulcottah on the coast of Coromandel, has, by the advice of Dr Russel at Madras, and at the expence of the East India Company, under Sir Joseph Bank's direction, begun to publish an elegant but very expensive work on the useful plants of India*.

Johann Christoph Wendland, born at Landau, and overseer of the gardens at Herrnhausen, near Hanover, has made many important and interesting experiments and discoveries on the great number of plants which are cultivated there. Those he has communicated to the world in several treatises, especially in his greater works †.

C. H. Per-

Ejusd. Nova genera plantarum, pars prima. Lipsiae. 1797. fol. with 6 elegantly illuminated plates. It contains some species of fungi.

* Plants of the coast of Coromandel, selected from drawings and descriptions presented to the Hon. Court of Directors of the East India Company, by William Roxburgh, M D. Vol. I. London. 1795. in large folio. Only 3 numbers have appeared, each with 25 beautiful plates, drawn very faithfully after nature. Many new Indian plants are delineated, very well dissected and described in English.

† Sertum Hanoveranum, seu plantae rariores quae in hortis Hanoverae vicinis coluntur, descriptae ab H. A. Schrader, delineatae et sculptae a J. C. Wendland. Goettingae. 1795, fol. maj. Mr Wendland published this work in the beginning with Mr Schrader, and three numbers of it have appeared. The 4th is published by Mr Wendland alone. The drawings and plates are done by this gentleman himself, in the first numbers the descriptions and the original observations are likewise his work, andthe last number is entirely his own. This work

is

C. H. Persoon, born at the Cape of Good Hope, now residing at Goettingen, has paid particular attention to the study of fungi, and is one of our first mycologists. Several of his treatises which contribute much to the elucidation of his subject, are inserted in Usteri's annals. One particularly important is separately printed*. He has promised a larger work on the fungi.

Francis Masson, a gardener and zealous botanist. The king of Great Britain sent him in 1772 to the Cape of Good Hope to collect plants for the botanic garden at Kew. He remained there two years and a half. After his return he made several botanical journeys to the warmer climates at the expence of the emperor of Germany, and of the kings of France and Spain. He was sent a second time at the expence of England in 1786, to the Cape of Good Hope, where he remained ten years, and during this long time he made more discoveries than the first time,

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is now finished, but it will be continued by Mr Wendland alone under the title, Hortus Herrenhusanus. It contains 24 plates, prettily coloured, of new and little known plants.

Botanische Beobachtungen nebst einigen neuen Gattungen und Arten von J. C. Wendland. (Botanical observations, with a few new genera and species), Hanover, 1798. fol. with 4 coloured plates, which contain very distinct representations of 33 dissected plants.

Ejusd. Ericarum icones et descriptiones. Fasc. I. Hanoverae. 1798. 4to. This fascicle contains drawings of 6 species of heath, very prettily coloured, with a description in German, and their characters in Latin.

* Observationes mycologicae, seu descriptiones tam novorum quam

time, and more than any person before him had done. He has published his discoveries* of several new species of Stapelia.

Samuel Elias Bridel was born November 28, 1763, at Crassier, a small village in the canton of Bern. He went to Paris, and travelled through the mountains of Switzerland to collect plants, especially mosses. Mr Bridel resides at present at Gotha in Saxony. We are indebted to him for a complete history of the musci frondosi, which he still continues †.

Eugenius Johann Christoph Esper, Professor at Erlangen, was born at Wundsiedel, June 25, 1742. His merit is very great in Zoology and Entomology, as appears by his writings on the Papiliones of Europe, and on Zoophyta. He has commenced a complete

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quam notabilium fungorum, exhibitae a C. H. Persoon. Pars prima. Lipsiae. 1796. 8vo. with 6 coloured plates.

* Stapeliae novae, or a collection of several new species of that genus discovered in the interior parts of Africa, by Francis Masson. Lond. 1795. fol. with 41 neatly coloured plates. Each plate contains a new species. During his travels in the interior of Africa he took up those succulent plants out of the soil with their root, and cultivated them in his garden at Cape Town, and thus had an opportunity of seeing many flowers which escape travellers who make hasty journeys over a country.

† Muscologia recentiorum s. Analysis, historia, et descriptio methodica omnium muscorum frondosorum hucusque cognitorum, ad normam Hedwigii, a S. E. Bridel. Gothae. Tom I. 1797. II. Pars I. 1798. 4. The first volume contains the history of the musci frondosi, the discovery of the order, of the genera, and their varieties. The first part of the second volume

plete work on sea-plants or Fuci*, and is in this epoch the first German who has written on this difficult genus. However Esper only collects the known species, and does not examine what is still unknown, their organs of generation.

As the narrow limits of a sketch, do not permit us to introduce a complete history of botany, we shall give the names only of some other celebrated botanists. They are, Acharius, Afzelius, Baumgarten, Bellardi, Bolton, Bosc, [illegible]els, Curtis, Cyrillo, Dahl, Danaa, Desfontaines, Derrousseaux, Dickson, Dombey, Ehrhart, Euphrasen, Fahlberg, Froehlich, Funk, Geuns, Goodenough, Haenke, Hellenius, Holmskiold, Hoppe, Hornstaedt, Host, Isert, JUSSIEU, Lambert, La Peyrouse, Liljeblad, Lumnitzer, Martyn, Mutis, Nocca, Panzer, Patterson, Pavon, Poiret, Rohr, Roth, Ruitz, Ryan, Salisbury, Schmidt, Schousboe, Schrank, Schumacher, Sowerby, Thouin, Timm, Ucria, Villars, Walter, West, Wiborg, Willemet, Woodward, Zuccagni, and many others.

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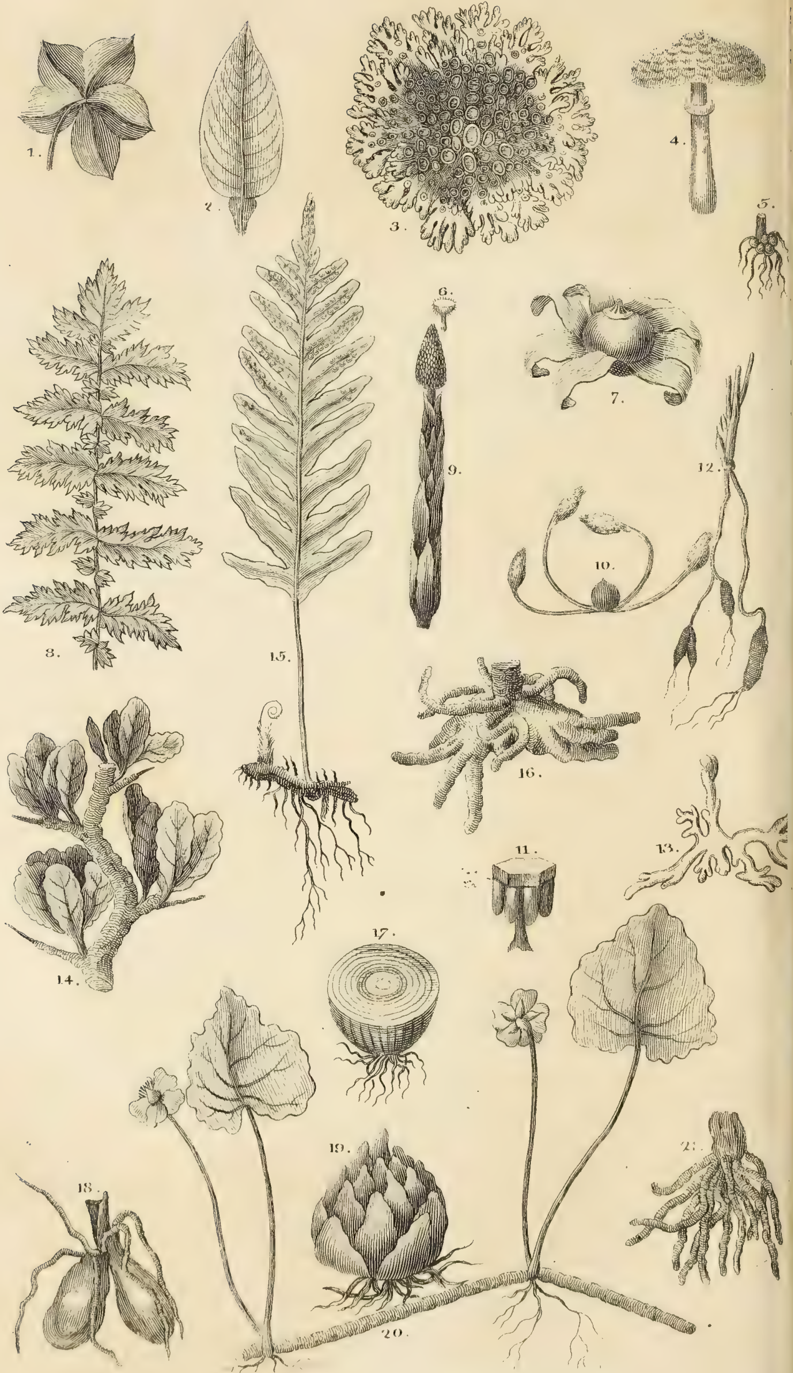
lume describes the species of the first genera. Of six uncoloured plates four represent the genera of the musci, and two some new species.

* Icones fucorum, *s.* Abildungen der Tange, published by E. J. C. Esper. Nuernberg. 1797. 4to. Two fascicles have only appeared with 63 coloured plates, containing the description of the represented species. It would have been better, had some of the figures been drawn with more accuracy and in a less coarse manner.

PLATE. 1.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EXPLANATION OF THE PLATES.

PLATE I.

FIG. 1. The leaf of the Pelargonium *peltatum* is peltated, p. 42. and pentangular, p. 30.

2. The leaf of the Orange, Citrus *Aurantium*, is ovate, p. 28. quite entire, p. 31. and has a winged footstalk, p. 24.

3. Lichen *stellaris* is an Alga, p. 130. with a stellated frons, p. 45. and scutellæ, p. 116. in the middle.

4. Agaricus *conspurcatus* is a Fungus, p. 130. the stipes is annulated, p. 25. the annulus is sessile, p. 55. the pileus umbonated, p. 5. and squarrose, p. 54.

5. A granulated root, p. 14. of the Saxifraga *granulata.*

6. Octospora, a small fungus, p. 130. with a naked stipes, p. 25. and a concave pileus, p. 54.

7. Lycoperdon *stellatum*, a fungus with a stellated volva, p. 53. of a spherical figure, p. 56. and ciliated orifice.

8. The leaf of the Spiræa *Filipendula*, is interruptedly pinnate, p. 37; the pinnula, p. 44. is lanceolate, and unequally dentated.

9. The scapus of the Equisetum *arvense*. This plant belongs to the Filices spiciferæ, p. 131.

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FIG. 10. The flower of the Equisetum much magnified, shewing four antheræ, and a style without a stigma.

11. The spike of the Equisetum consists of numerous peltated hexangular receptacles, raised on a footstalk. One of these receptacles is here much magnified, to which the horn-shaped indusia, p. 57. are attached, containing the flower exhibited in the former figure.

12. The root of the Spiræa *Filipendula*, which is tuberous and pendulous, p. 14.

13. The root of the Ophrys *corallorhiza* is dentated, p. 15.

14. Celastrus *buxifolius* has a flexuose stem, p. 19; thorns, p. 61; obovate leaves, p. 44. which stand in bundles, p. 41.

15. The Polypodium *vulgare* is a Filix which bears its flower and seed on the back of the frons, filix epiphyllosperma, p. 131; the root is horizontal, p. 18; the frons is circinated, p. 59. and pinnatifid.

16. A palmated root, p. 15. of the Orchis *latifolia*.

17. A tunicated bulb, p. 60. of Allium *Cepa*.

18. A testiculated root, p. 15. of Orchis *mascula*.

19. The scaly bulb, p. 60. of Lilium *bulbiferum*.

20. Sida *hederaefolia* has a sarmentose stem, p. 19. heart-shaped leaves, p. 27. which are repand, p. 32. petiolated, p. 42. and pallaceous, *ibid*. The flowerstalk is radical, p. 23. the perianth is simple, p. 78. the corolla is mallow-like, p. 83. the filaments are connate, p. 92.

21. The bundled root, p. 15. of Ophrys Nidus avis.

PLATE II.

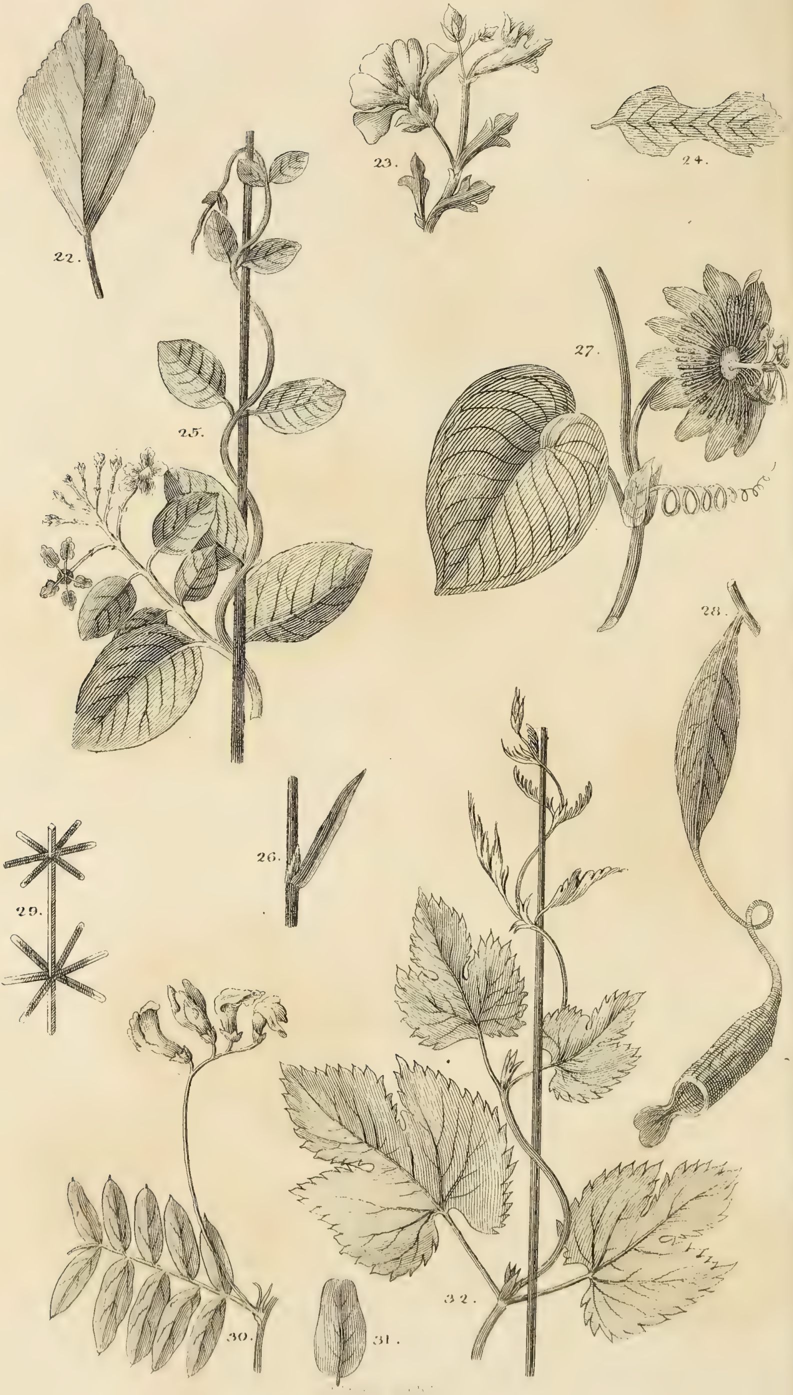
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PLATE II.

FIG. 22. A rhombic leaf, p. 29. of Hibiscus *rhombifolius*.

23. Malva *tridactylites* has a trifid leaf, p. 27. a one flowered peduncle, p. 23. a double perianth, p. 75. a malvaceous corolla, p. 83. and belongs to the 16th class of Linnæus, viz. Monadelphia, p. 147.

24. A panduræform leaf, p. 29. of Euphorbia *cyathophora*.

25. Banisteria *purpurea* has a twining stem turning from the right to the left, p. 19. opposite leaves, p. 40. which are elliptic, p. 28. and bear a corymbus, p. 79.

26. Part of a straw, p. 22. with a leaf, and at the base a strap, p. 51.

27. The Passiflora *tiliæfolia* has a round stem, p. 20. a heart-shaped leaf, p. 27. double stipulæ, p. 47. an axillary tendril, p. 57. a one-flowered peduncle, p. 23. a polypetalous corolla, p. 81. nectaria which consist of straight threads, p. 87. and a pedicelled germen, p. 96.

28. Nepenthes destillatoria has a lanceolate leaf, p. 29. which bears a pedicelled ascidium, p. 51.

29. A four-cornered stem, p. 21. with, with stellate leaves, p. 41. which stand six together, *ibid.* and are linear, p. 29.

30. A vetch with leaves alternately pinnate, p. 37. the pinnulæ, p. 44. are mucronated, p. 26. the flowers stand in a racemus, p. 69. the corolla is papilionaceous, p. 83.

31. An ovate leaf, p. 28. which is emarginated, p. 27.

32. The Humulus *lupulus* has a stem which twines from the left to the right, p. 19. opposite

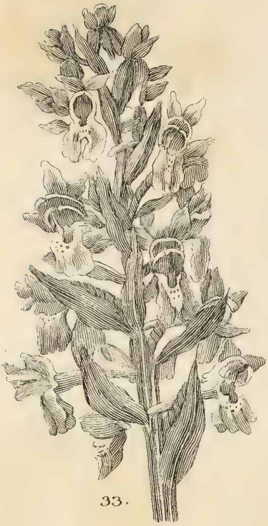
FIG. 32. leaves, p. 40. tri-lobed, p. 30. and toothed, p. 32.

PLATE III.

33. The spike, p. 67. of the Orchis *latifolia*, having floral leaves, p. 48; the germen is below, p. 101; the corolla is orchideous, p. 84.
34. The panicle, p. 72. of the Poa *triviàlis*.
35. The leaf of the Lacis *fluviatilis*, which is laciniate, p. 30. and curled, p. 33.
36. A compound Umbel, p. 70. with an universal involucrum, p. 52. and a partial one.
37. The Catkin, p. 73. of the Hazel, covered with scales, p. 79.
38. Bupleurum *rotundifolium*, with a perfoliate stem and leaf, p. 20; it has a depauperate umbel, p. 71. and a pentaphyllous involucrum, p. 52.
39. The Scolopendrium *vulgare*, with a dedaleous leaf, p. 27. belongs to the Filices epiphylospermæ, p. 131.
40. The filiform receptacle, p. 127. of the Hazel.
41. The flower of the Arum *maculatum*, with an univalve spatha, p. 49. in the centre of which stands the spadix, p. 72.
42. The Spadix of the foregoing flower, with female flowers below, and male flowers above.
43. The Cyme, p. 71. of the Viburnum *Opulus*, having large neuter flowers, p. 216. at the extremities.
44. Sagittaria, *sagittifolia* has arrow-shaped leaves, p. 28. a channelled leaf-stalk, p. 24. and a three sided stalk (*scapus*), p. 23. The flowers

stand

PLATE. III.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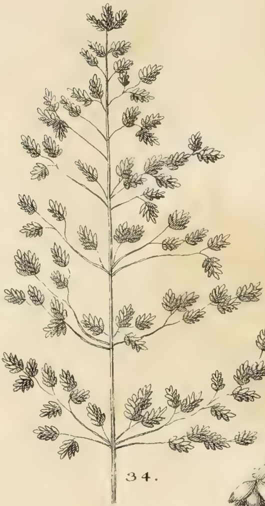
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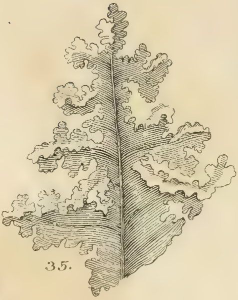
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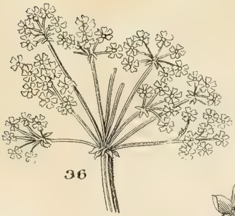
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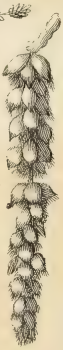
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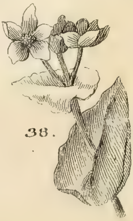
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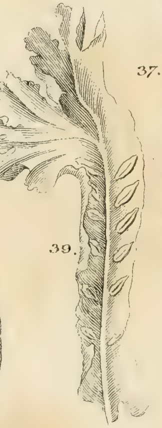
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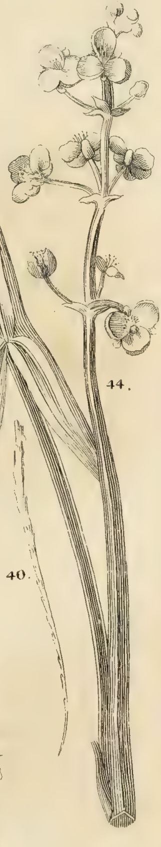
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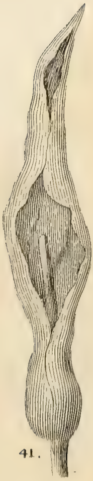
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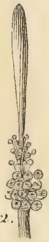
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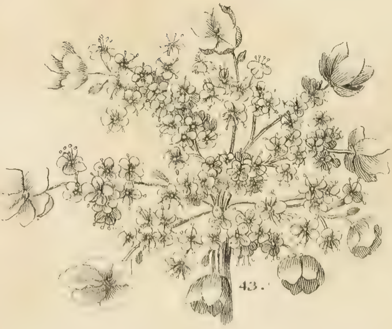
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PLATE IV.

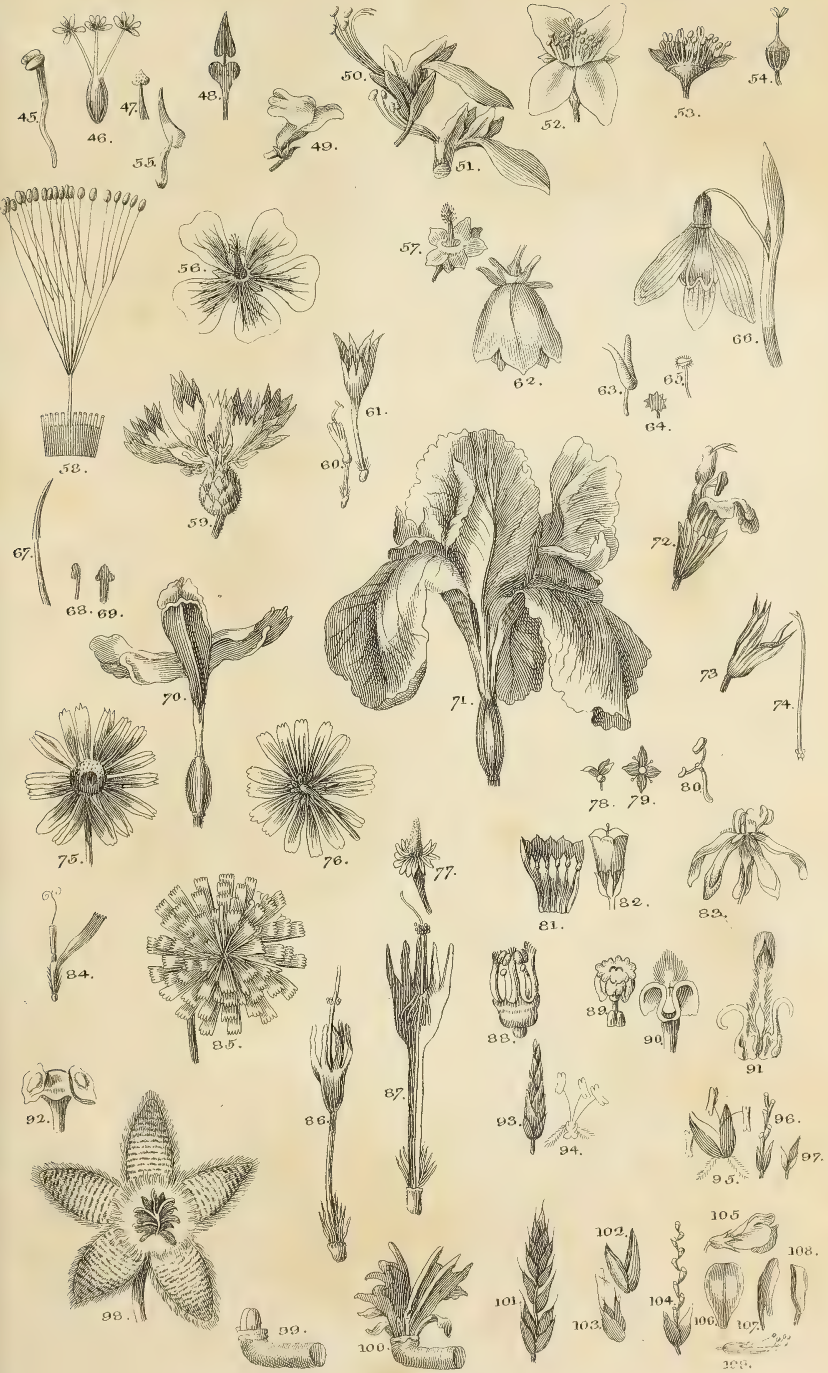

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FIG. 44. stand in whirls, p. 65. and are tripetalous, p. 83.

PLATE IV.

45. A stamen of the Digitalis *purpurea*, the filament, p. 92. is incurved, p. 93. the anther doubled, p. 94.
46. The pistil of the Turnera *frutescens*. The germen is oblong and trisulcated, with three styles which are multifid, p. 97.
47. A stamen of the same, the filament of which is dilated, p. 92. and its anther cordated.
48. A stamen with a compressed cordate filament, p. 92. and erect anther, p. 95.
49. The flower of the Antirrhinum *Orontium*, has a personate corolla, p. 82. with a spur at the bottom, p. 89.
50. The whole flower of the Teucrium *fruticans* has has an unilabiate corolla, p. 82. the filaments are filiform, p. 92. turning up (*adscendentia*), the style fililiform, p. 97. and the stigma bifid, p. 99. The flower belongs to the class Didynamia.
51. The Corolla of the foregoing flower is monopetalous, p. 81. and has only the under-lip, p. 85.
52. The flower of the Philadelphus *coronarius*, with a four petalled corolla, p. 83.
53. The monophyllous quadrifid perianth, p. 75. of the foregoing flower. As the stamina are numerous, and inserted in the calyx, the plant belongs to the class Icosandria.
54. The pistil of the same flower.

FIG. 55. A stamen with a compressed filament and incumbent anther, p. 95. which is moveable, *ibid.*

56. A malvaceous corolla, p. 83. with connate filaments, p. 92.

57. The double perianth, p. 75. of the same flower, in the centre of which is seen the united filaments.

58. The stamina of the Carolinea *princeps*, the filaments of which are connected below, but above stand free; in this figure the most of the filaments are cut away, leaving one to shew that it is branched, p. 93. The anthera is round and upright.

59. The flower of the Centaurea *Cyanus* is compound, p. 86. and enclosed in a common perianthium, p. 77. which is imbricated and turbinated, p. 78.

60. A floret taken from the disc of the foregoing flower; it is tubular, p. 81. and the germen is crowned with a pappus, p. 79.

61. A floret from the radius of the same flower, which is difform, p. 82.

62. The flower of the Campanula *rotundifolia*, with a five-parted perianth, p. 75. and a bell-shaped corolla, p. 81.

63. The stamen of a Vaccinium has a filiform filament and an awned anther, p. 94.

64. The stamen of the Yew-tree, with a peltated and dentated anther, p. 94.

65. The stamen of a Lamium, with an incumbent anther, which is hairy, p. 94.

66. The Galanthus *nivalis* has a one-flowered spatha, p. 50. a liliaceous, three-petalled corolla, p. 83. a triphyllous crown, p. 90. and a germen inferum, p. 101.

FIG. 67. A stamen with an awl-shaped filament, p. 92. and an erect, p. 95. arrow-shaped, p. 94. anther.

68. A stamen of the Glechoma *hederacea*, with a kidney-shaped anther, p. 93. which is lateral, p. 95.

69. A stamen with an adnate anther, p. 95.

70. The pistil of the Iris *germanica* has an oblong sulcated germen, a filiform style, p. 97. with three stigmata, which are petal-like, p. 99.

71. The flower of the same, with a germen inferum, p. 101. a one-petalled, liliaceous six-parted corolla; three of the segments are erect, and three are bent back; on these last there is a beard, p. 90.

72. The flower of the Salvia *officinalis*, with a ringent corolla, p. 82.

73. The bilabiated perianthium of the same, p. 75.

74. The pistil of the same has four seeds, a filiform style, and divided stigma.

75. The Bellis *perennis* has a compound flower, p. 86. it is a flos radiatus, p. 87. the centre is called the *disc*, and the rim the *ray*.

76. The same flower seen from behind, to shew the common hemispherical anthodium, p. 78.

77. A conical common receptacle, p. 126.

78. The flower of the Galium *boreale* seen sideways.

79. The wheel-shaped corolla of the same, p. 82. belonging to the class Tetrandria, p. 147.

80. A stamen of the Salvia *officinalis*, with a moveable articulated filament, p. 93.

81. The flower of the Symphytum *officinale* slit up, to shew the fornices, p. 90. under which the stamina stand, and shew the plant to belong to the class Pentandria.

82. The same flower has a cup-shaped corolla, p. 81.

83.

FIG. 83. The flower of the Periploca *græca*, with its pentapetalous corolla, p. 83. and horn-like threads, p. 90.

84. A ligulated corolla, p. 82. of the Hieracium *sylvaticum*; the antheræ are connate, p. 95. which is the character of the class Syngenesia.

85. The compound flower of the same, consisting wholly of ligulate florets. It is called a semifloscular flower, p. 86. and belongs to the order of Polygamia æqualis.

86. A tubular floret, p. 81. of the Carduus *nutans*.

87. The same opened longitudinally, to show the character of the 19th class.

88. The flower of the Periploca *græca*, without the corolla and horn-shaped filaments. It is merely the hood (cucullus, p. 89.) with the stamina that are shown.

89. The pistil of the same much magnified, the germen double, the style simple, and the stigma very large.

90. A stamen of the same plant highly magnified, with the beard, p. 90.

91. A petal of the same bending outwards, with two horn-shaped filaments.

92. The same with figure 90, only the anthers burst.

93. A many-flowered spicula, p. 67. of a grass, the Festuca *elatior*.

94. The three stamina, with the pistil and nectarium of the same grass. The nectarium, p. 91. surrounds the seed; the stigmata are plumose, p. 99. the filaments capillary, p. 92. and the antheræ bifid, p. 94.

95. The corolla of the same grass with the pistil and stamina; the corolla is bivalve, p. 77.

96. The bivalve glume with the seed.

PLATE .V.

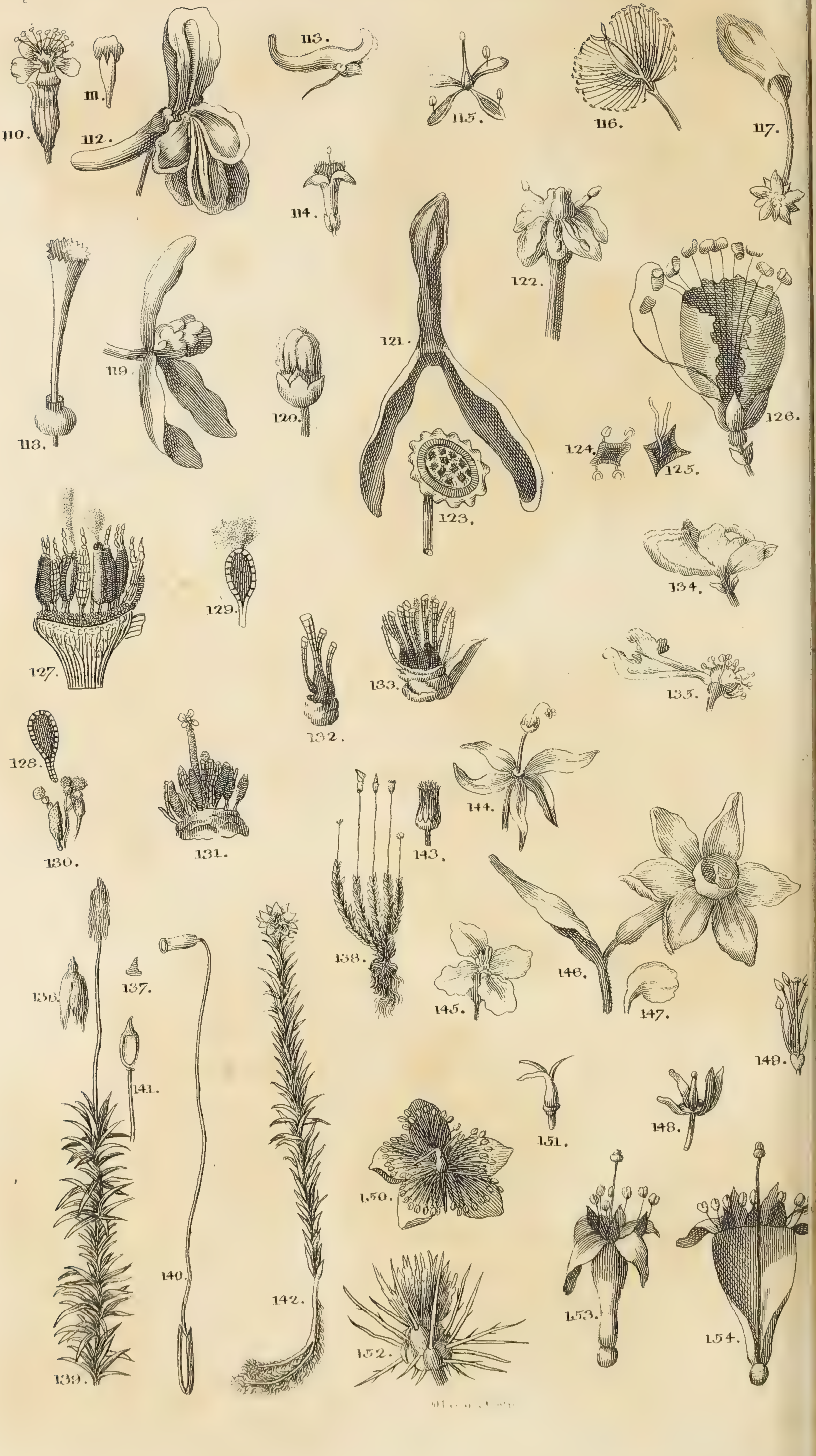
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FIG. 97. The same glume apart, by which we may see that the valves, p. 77. are of unequal length.
98. The flower of the Stapelia *hirsuta*, diminished about a fifth part.
99. The two germens of the same flower.
100. The polyphyllous crown, p. 90. of the same.
101. A many-flowered spicula of the Bromus *secalinus*.
102. The bivalve glume of the same.
103. The bivalve corolla, with an awn, p. 62.
104. The bivalve glume, with the zigzag rachis.
105. The papilionaceous corolla, p. 83. of a Vicia.
106. The vexillum of the same, p. 84.
107. The alæ of the same, *ib.*
108. The carina of the same, *ib.*
109. The stamina of the same showing the character of the class Diadelphia, p. 147.

PLATE V.

110. The flower of the Lychnis *Viscaria* has a tubular perianthium, p. 76. a pink-like corolla, p. 83. and belongs to the class Decandria.
111. The petal, p. 80. of this plant has a long unguis, p. 86. and a bidentated crown, p. 90.
112. The flower of the Cucullaria *excelsa* much magnified. It has an irregular corolla, p. 84. a spur, p. 89; the antheræ, p. 93. are attached to the undermost petal, and the stigma, p. 98. is club-shaped.
113. The same flower of its natural size.
114. The funnel-shaped corolla, p. 81. with a beard, p. 70. of the Lasiostoma *cirrhosa*.

FIG. 115. The flower of the Rupala *montana,* the stamina of which stand on the tips of the petals.

116. Lacis *fluviatilis* has a simple flower, without calyx or corolla. It is called a flos nudus, p. 100.

117. The flower of the Ascium *coccineum,* shewing an ascidiform bractea on a footstalk, p. 51.

118. The flower of the Matthiola *scabra,* with an urceolated perianthium, p. 76. and a cup-shaped corolla, p. 81. which is crenated.

119. The flower of the Ruyschia *Surubea* has a sessile, bi-lobed, ascidiform bractea, p. 51.

120. The flower-bud of the same, without the ascidiform bractea.

121. The ascidiform bractea separated.

122. The flower opened.

123. The receptaculum placentiforme, p. 127. of the Dorstenia *cordifolia,* surrounded with flowers.

124. A single male flower of the same, p. 100.

125. A female flower, *ib.*

126. The flower of the Dimorpha *grandiflora,* with its singular corolla.

127. The male flower of one of the Musci frondosi, with succulent filaments, p. 91. and the stamina, p. 96. of which some disperse the pollen, others are not so far advanced, and some have already shed their pollen.

128. A stamen of the Sphagnum *palustre.*

129. The same in the act of throwing out the pollen.

130. A filament with three club-shaped succulent filaments, of one of the Musci frondosi.

131. The hermaphrodite flower, of such another Moss with pistillum and stamina.

132. The female flower of such a moss, without succulent filaments.

133. Another with succulent filaments.

FIG. 134. The flower of an Aconitum, with an irregular corolla, p. 84.

135. The pedicelled cuculli or hoods, p. 89. of the same, with stamina and pistillum.

136. The villous calyptra, p. 112. of the Polytrichum *commune*.

137. The operculum, p. 112. of the same.

138. Bryum *androgynum* has a branched surculus, p. 25; the male flowers rest upon footstalks, and are capituliform, p. 73; the thecæ, p. 112. stand upon long terminal setæ, p. 25; on one of them is seen a calyptra dimidiata, p. 112; another has an operculum, and one wants it.

139. The Polytrichum *commune* has a simple surculus, p. 25; the theca is covered with a hairy calyptra.

140. The bristle, p. 25. of this Moss, with the perichaetium, p. 80. and the capsule without an operculum.

141. The theca of the same Moss, with the operculum and apophysis, p. 114.

142. The same Moss, with male stellated flowers, (flos disiformis) p. 74.

143. The flower of the Senecio *vulgaris* has a double anthodium, p. 79.

144. The flower of the Sterculia *crinita* has a pedicelled germen, p. 76.

145. The flower of the Cheiranthus *annuus* has a cross-like flower, p. 83.

146. The flower of a Narcissus, with a one-flowered spatha, p. 50. a liliaceous corolla, p. 83. and a monophyllous crown, p. 90.

147. The petal of the Cheiranthus *annuus*, where the expansion, p. 86. and the claw, *ib.* are seen.

FIG. 148. The tetraphyllous perianth, p. 75. of this flower, with the pistillum and a gland, p. 87. in the bottom of the flower.

149. The style and the stamina of the same plant, to shew that it belongs to the class Tetradynamia.

150. The flower of a Hypericum, having a rosaceous corolla, p. 83. the filaments united in several parcels, which is the character of the class Polyadelphia.

151. The pistillum of the same flower, with three styles, § 140.

152. The flower of the Centaurea *Verutum*, having a common thorny perianthium, p. 78. the thorns are branched.

153. The flower of the Fuchsia *excorticata*, with a funnel-shaped corolla, p. 81. a tetraphyllous crown, p. 90. and a three-lobed stigma, p. 98.

154. The same flower cut open longitudinally, to shew that it belongs to the class Octandria.

PLATE VI.

155. The capsule, p. 103. of the Colchicum *autumnale*, cut over transversely. It is trilocular, p. 104.

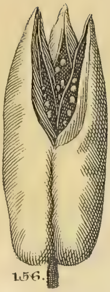
156. The same capsule opening at the apex, p. 105. and having three valves, 104.

157. Two seeds of the Caucalis *daucoides*, which are prickly.

158. A single seed of the same.

159. The fruit of the Magnolia *grandiflora* has the appearance of a strobilus, p. 118. It consists

PLATE. VI.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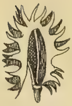
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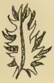
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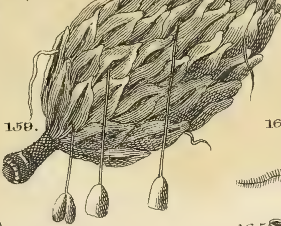
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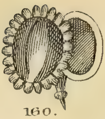
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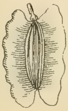
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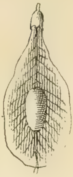
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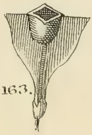
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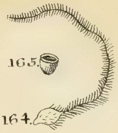
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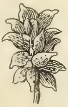
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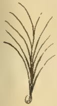
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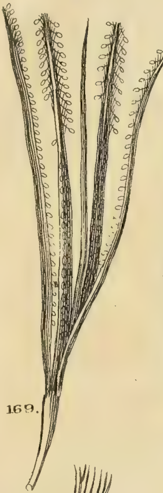
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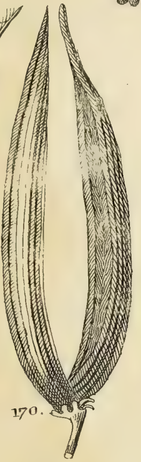
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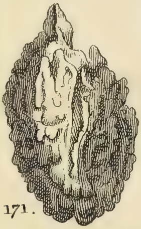
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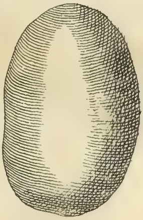
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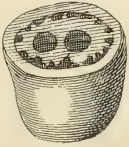
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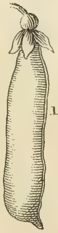
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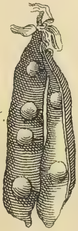
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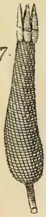
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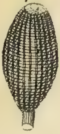
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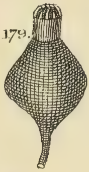
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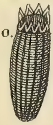
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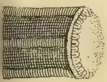
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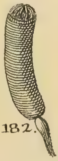
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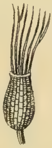
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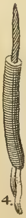
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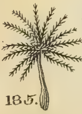
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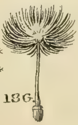
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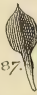
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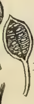
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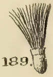
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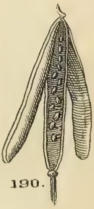
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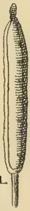
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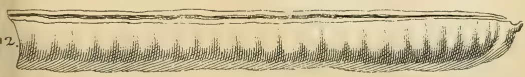
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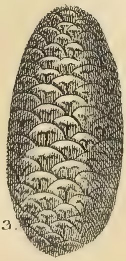
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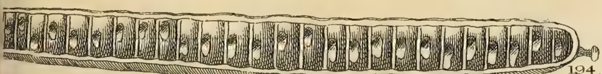
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FIG. 159. sists of unilocular bivalve capsules, p. 104. that lie over one another. The seeds have a very long umbilical cord, p. 119. by which they hang down, but they are surrounded by a succulent artillus, p. 120.

160. Two seeds of the Tordylium *syriacum*, having a crenated margin.

161. The seed of the Tapsia *villosa*, with wings, p. 124. and ribs, *ib.*

162. The winged fruit, (samara, p. 103.) of the Ulmus *Americana*.

163. The same cut across, to shew the position of the seed.

164. The seed of the Clematis *Vitalba*, with its tail, p. 123.

165. A transverse section of the seed of the Adonis *vernalis*.

166. A cluster of the utriculi, p. 102. of the same seeds.

167. A linear capsule of the Epilobium *montanum*.

168. A seed from this capsule, with the tuft, p. 123.

169. The same capsule burst, to shew the columella, p. 104.

170. The folliculus, p. 103. of the Periploca *græca*.

171. The kernel of the drupa of the Pterocarpa *montana* about 1-3d diminished.

172. The same drupa, p. 106. entire, likewise diminished.

173. A transverse section of the same drupa, to shew the bilocular nut, p. 107.

174. The pod, (legumen, p. 110.) of the common pea.

175. The same opened, to show the character of a legumen.

176. The theca, p. 112. of the Polytrichum *commune* much magnified: on the under part is

FIG. 176. the apophysis, p. 114. which is four-cornered, with a peristoma, p. 113. having 32 teeth, closed by an epiphragma, p. 114.

177. The theca of the Tetraphis *pellucida,* having a peristoma with four teeth.

178. The theca of the Gymnostomum, with a naked peristoma, p. 113.

179. The theca of the Splachnum *ampullaceum,* with a large apophysis, and a peristoma with eight teeth.

180. A Grimmia, having a peristoma with sixteen teeth.

181. A Neckera, with a double row of teeth at the peristoma.

182. A Dicranum, with a peristoma having sixteen bifid teeth, p. 113.

183. A Trichostomum, with the same sort of peristoma, only the teeth are much more deeply divided.

184. A Barbulà, with twisted teeth at the peristoma, p. 113.

185. A seed with a pappus supported on a footstalk, p. 121 ; the pappus is plumose, p. 122.

186. A seed with a hairy pappus, p. 122. supported on a footstalk.

187. A silicle, p. 109.

188. The partition, p. 103. of the same, with seeds attached to it.

189. A seed with a sessile pappus, p. 121. which is setaceous, p. 122.

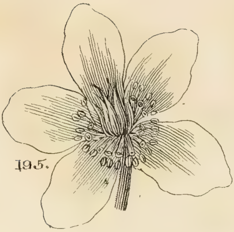
190. A siliqua, p. 109. burst, so that the partition is seen.

191. The same shut.

192. The loment, p. 111. of the Cassia *Fistula.*

193. The strobile, p. 116. of the Pinus *picea,* much less than the natural size.

PLATE VII.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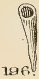
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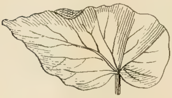
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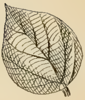
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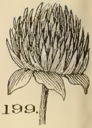
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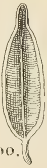
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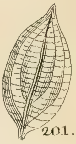
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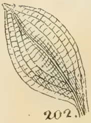
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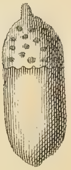
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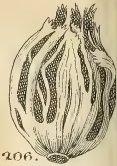
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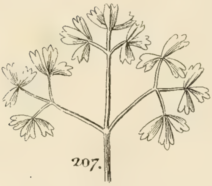
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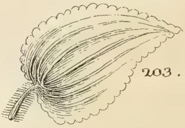
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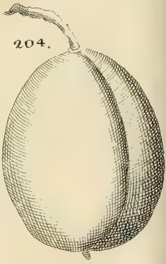
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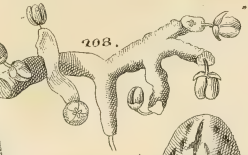
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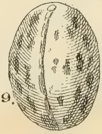
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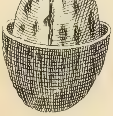
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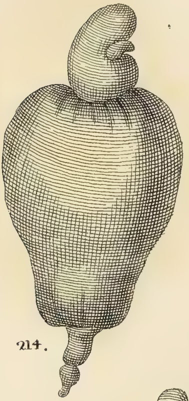
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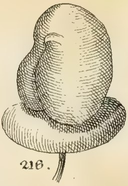
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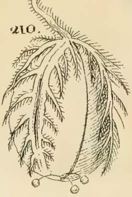
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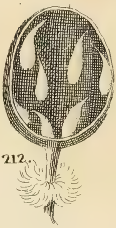
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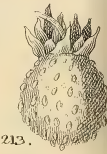
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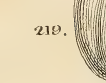
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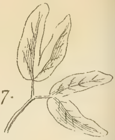
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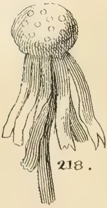
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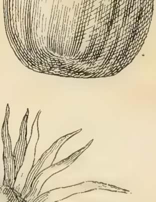
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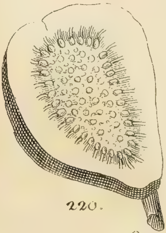
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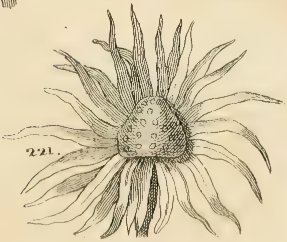
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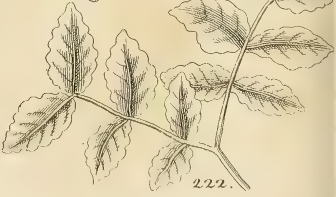
222.

FIG. 194. The loment of the Cassia *Fistula* opened, to shew the character of it.

PLATE VII.

195. The flower of the Helleborus *niger*; it is rosaceous, p. 83. and belongs to the class Polyandria.

196. The nectarium of this flower, which is a cucullus, p. 89.

197. The heart-shaped oblique leaf, p. 29. of the Begonia *nitida*. The margin is undulated, p. 31. The veins are so divided that it is venoso-nerved, p. 34.

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199. A leafy capitulum, p. 66. of the Gomphrena *globosa*.

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201. A quintuple-nerved leaf, p. 34.

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203. A crenated, p. 32. heart-shaped leaf, which is seven-nerved, p. 34.

204. The entire drupa, p. 106. of the Nutmeg, Myristica *moschata*.

205. The common Acorn, which is a nut, p. 105.

206. The nut of the Myristica *moschata*, surrounded with what is called Mace, which is properly a torn arillus, p. 120.

207. A folium triternatum, p. 36.

208. The Hovenia *dulcis*, with its flowerstalk, which changes into a fleshy esculent receptacle, p. 125.

209. The nut of the Myristica *moschata*, without the arillus.

FIG. 210. The fruit of the Passiflora *fœtida,* with its perianthium abiding, p. 74.

211. The nut of the Myristica cut across, to shew the kernel, p. 106.

212. The succulent fruit or pumpkin, p. 108. of the Passiflora *fœtida,* cut up longitudinally.

213. The strawberry, Fragaria *vesca,* having a fleshy receptacle, p. 125. and bearing naked seeds.

214. The fruit of the Cashew-nut tree, Anacardium *occidentale,* with a pear-shaped fleshy receptacle, p. 125. and a nut, p. 105.

215. Gomphia *Japotapita* has a fleshy receptacle, p. 125. bearing berries, p. 107.

216. Semicarpus *Anacardium* has a fleshy receptacle and a nut.

217. The leaf of the Mimosa *unguis cati* is a folium bigeminatum, p. 35.

218. A flat receptacle, p. 125. which is punctured, p. 127.

219. The common fig has a closed receptacle, p. 127.

220. The same cut up longitudinally, to shew the flowers.

221. A conical receptacle, p. 126.

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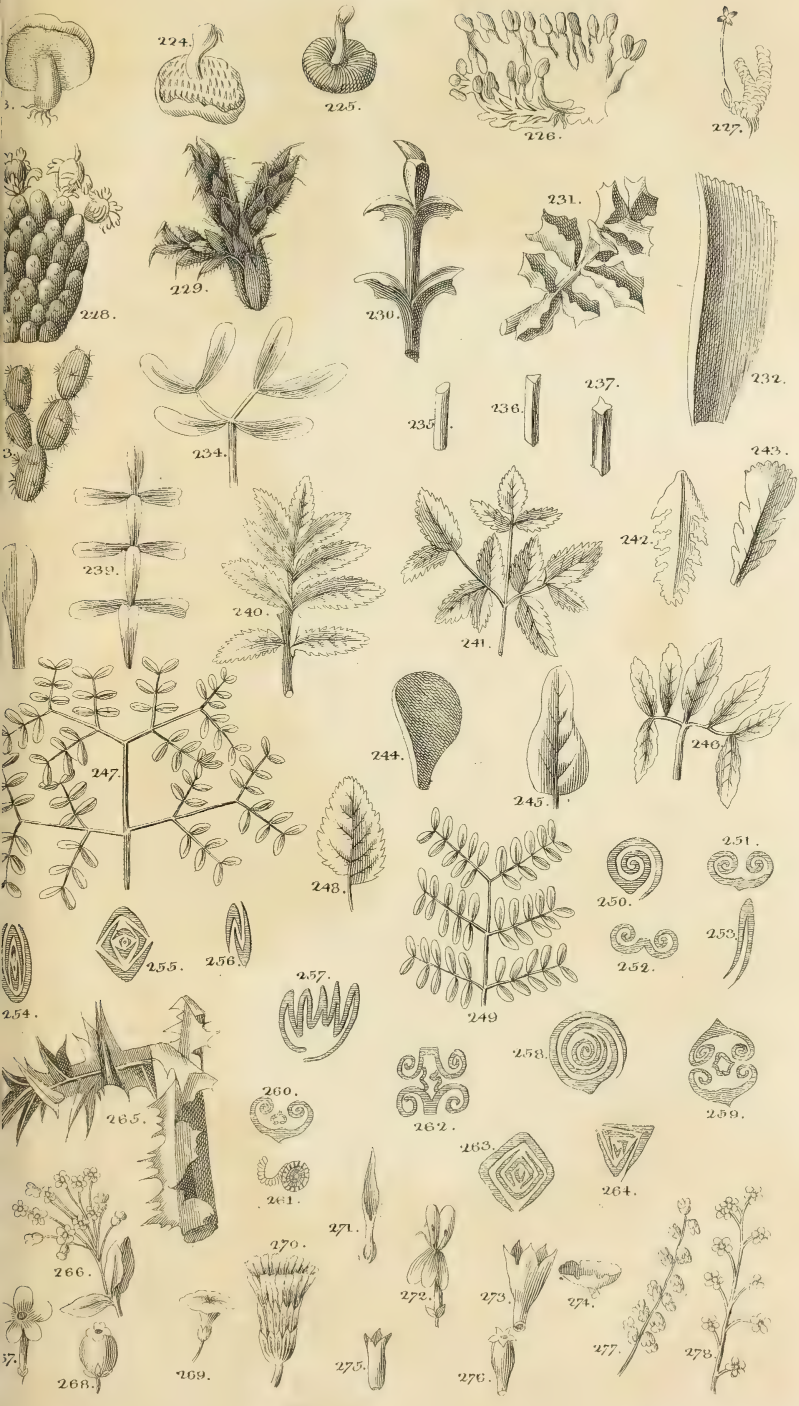
PLATE VIII.

223. The Boletus *bovinus* is a fungus, p. 130. with a naked stipes, p. 25. a round pileus, p. 54. and pores on the under surface, p. 56.

224. The Hydnum *imbricatum,* a fungus, with prickles, p. 56. on the under surface of the pileus.

225. The Agaricus *integer,* a fungus with lamellæ, p. 55. on the under side of the pileus.

PLATE VIII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229. The Berckheya *ciliaris*, with imbricated leaves, p. 41. which are ciliated.

230. The Mesembryanthemum *uncinatum*, with a hook-shaped leaf, p. 40.

231. The Mesembryanthemum *deltoideum*, with a deltoid leaf, p. 40.

232. A scimetar-shaped leaf, p. 39.

233. An articulated stem, p. 21.

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235. A half-round stem, p. 20.

236. A three-sided stem, p. 20.

237. A four-angled stem, p. 20.

238. A spatulate leaf, p. 29.

239. A jointedly pinnate leaf, p. 37. of the Fagara *Pterota*.

240. A decursively pinnate leaf, p. 37. of the Melianthus *major*.

241. A doubly compound leaf, p. 38. of the Aegopodium *podagraria*.

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243. A folium lyratum, p. 31.

244. A folium dolabriforme, p. 40.

245. A folium parabolicum, p. 29.

246. A folium pedatum, p. 36. of the Helleborus *niger*.

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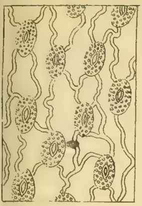
278. A simple racemus, p. 79.

PLATE IX.

279. A section of the cuticle of the Lilium *chalcedonicum,* much magnified, to shew the openings, with the lymphatic vessels, § 236.

PLATE. IX.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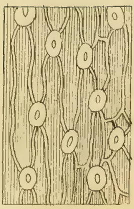
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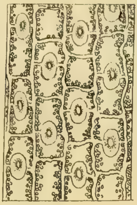
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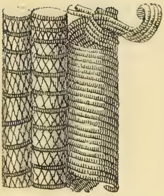
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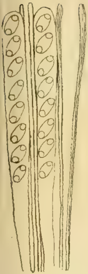
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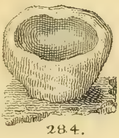
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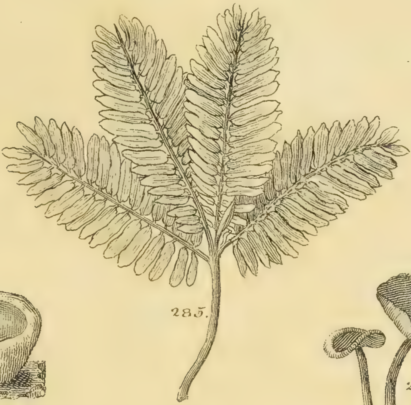
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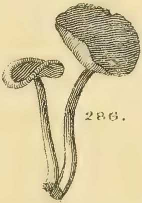
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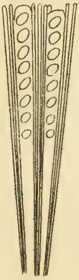
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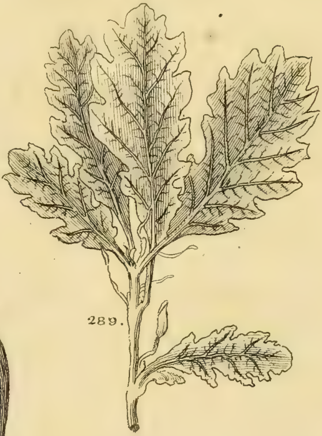
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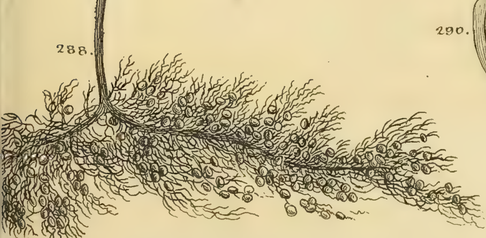
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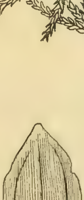
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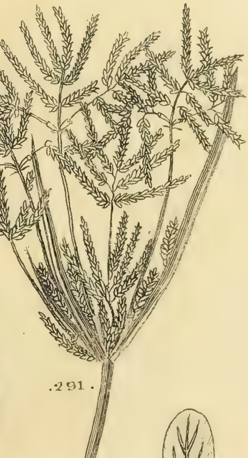
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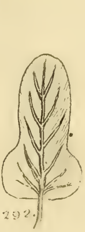
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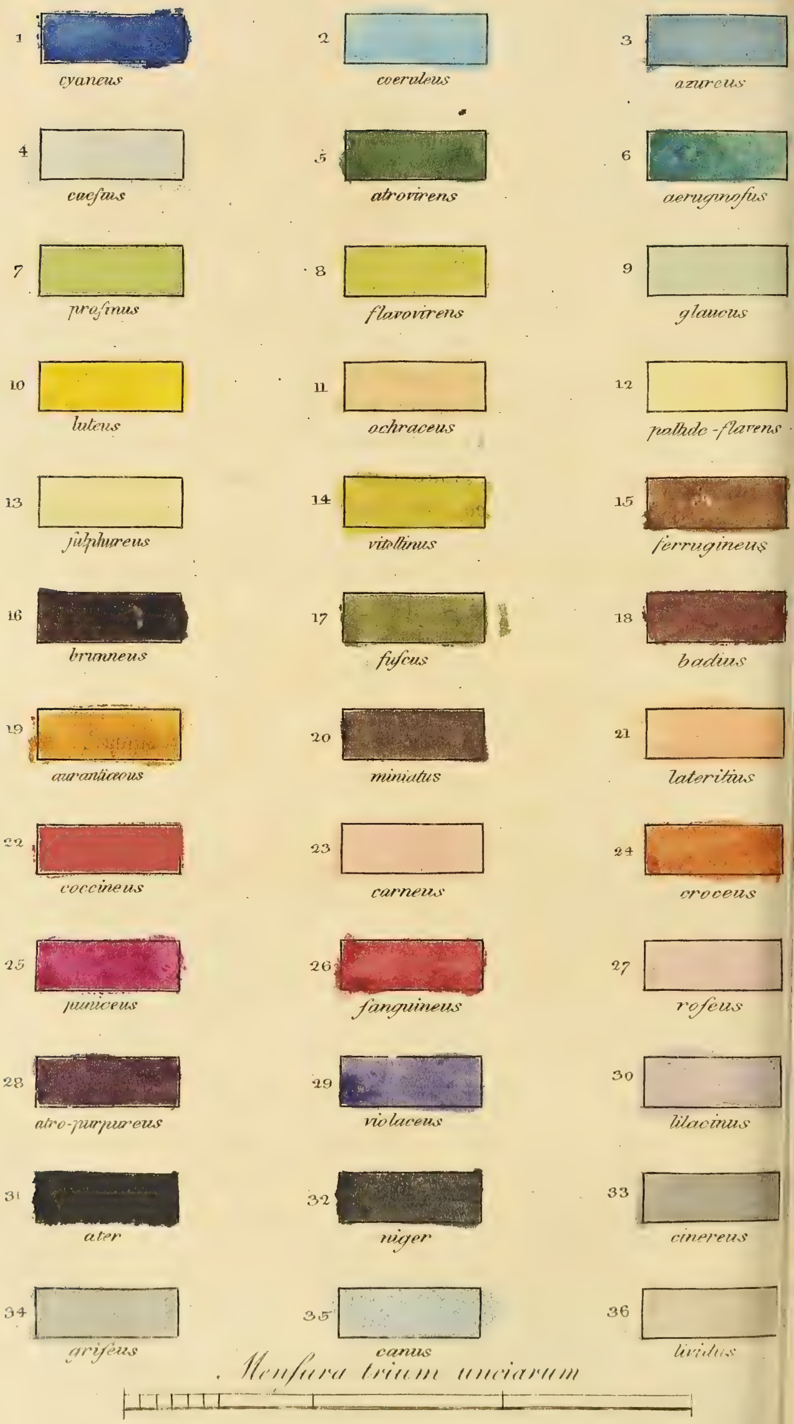
PLATE. X.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11 ochraceus
12 pallide-flavens
13 ſulphureus
14 vitellinus
15 ferrugineus
16 brunneus
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30 lilacinus
31 ater
32 niger
33 cinereus
34 griſeus
35 canus
36 lividus
Menſura trium unciarum

FIG. 280. A section of the cuticle of the Allium *Cepa*, the common onion, much magnified, to shew the openings and the lymphatic vessels, § 236.

281. A section of the cuticle of Dianthus *Caryophyllus*, common Pink, much magnified, to shew the same.

282. Three air-vessels, § 235. much magnified.

283. The Capsules of the Octospora *pustulata* much magnified, in which are seen two seeds in each membrane, p. 115.

284. The Octospora *pustulata* of its natural size.

285. A folium digitato-pinnatum, p. 37. of the Mimosa *pudica*, the Sensitive plant.

286. The Octospora *villosa* of its natural size.

287. The capsules of the same much magnified, to shew the eight seeds.

288. The young stalk of the Utricularia *vulgaris*, with the roots, at which hang the little bladders, p. 51.

289. A branch of the common oak, having sinuated leaves, p. 30. with the ramenta, p. 48. between them.

290. A folium triplinevrium, p. 34.

291. The flowering umbel of a Cyperus, on the principal peduncle of which is to be seen an ochrea, p. 50.

292. A folium auriculatum, p. 28.

PLATE X.

Contains the various colours which are described at p. 197. The scale at the foot is used for the various measures of plants mentioned in p. 10.

ERRATA.

Page 16, line 9, *for* ſimpliciſſima, *read* ſimpliciſſimus.
—— 19, line 26, *for* from the left to the right, *read* from the right to the left.
—— 29, laſt line but one, *for* capillaris, *read* capillare.
—— 35, line 1, *for* cucullatus, *read* cucullatum.
—— 45, line 17, *for* coricea, *read* coriacea.
—— 47, line 21, *for* oppoſitifolia, *read* oppoſitifoliæ.
—— 52, after line 18, *inſert*, 2 Partial, *(partiale)*, which incloſes only the umbellulæ.
—— 67, line 2, *for* terminalis, *read* terminale.
—— line 4, *for* axillaris, *read* axillare.
—— 67, line 7 *for* Ear, *read* earlet or little ſpike.
—— 69, line 18, *for* ſecunda, *read* ſecundus.
—— 77, laſt line of the text, *read* but one as in.
—— 78, line 5, *for* polyphyllus, *read* polyphyllum.
—— 109, line 8, after ſuccoſa, add s. baccata.
—— 131, line 3, for *hepaitci*, read *hepatici*.

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